THE

ELECTRICAL REVIEW.

VOL. XXX. MARCH 11, 1892. No. 746

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THE CHATHAM ELECTRIC LIGHTING ACCIDENT.

THE accident which may yet prove fatal to one of the Chatham Electric Light Company's foremen, and the death of one of the public, last Friday evening, from an electric shock, will once more revive the fears and apprehensions with which high tension apparatus have been generally regarded. Nobody needs reminding that there is danger lurking in gas, steam boilers, kitcheners, paraffin lamps, and many other things in commercial and domestic use, but the accidents which arise from the use of them are mainly credited to carelessness or inattention to well-known rules which govern their action, rather than to ignorance of their nature.

With electricity, however, the public is not yet conversant, and the Chatham fatality will, we fear, cause a feeling of uneasiness amongst the company's customers, and generally throughout the country where high tension currents are transformed inside the consumer's premises.

The Foreman of linemen, named Readwin, had been engaged in replacing a transformer for one which he supposed had burnt out the day before, as the lamps in the shop would not light up. The same thing occurred when the fresh transformer was put on and Readwin, not finding anything else wrong to account for it, supposed there must be a loose connection in the primary work inside the premises, when, as a matter of fact, one of the service lines had become detached from the main which passes over the roof; but the man, not knowing this, tried the connections with the fuses by pulling the wire, which happened to be the one connected with the main. The cause of the shock being received was because the service lines being placed on a very damp wall, sufficient moisture had gathered on the surface of the insulation to cause the current to flow from the connection in the fuse box, and then in stepping from the dry wood on which he was standing, to the damp earth, the circuit was completed through Readwin's body, which drew him up, until by falling he jammed the cable between the fuse box and wall, upon which the damp wall took the current to earth, and so released him. It is stated that at the time of the accident Readwin was wearing one of his India-rubber gloves; if he had had both off he would probably have been killed.

The young man, Jay, was a salesman in the clothing department of Messrs. J. W. Taylor & Co., and he, seeing the place filled with smoke (caused by the burning of the insulation), and thinking the place was on fire, rushed down the stairs with an iron bar in his hand, accompanied by one of the workmen in the tailor's shop. The evidence of this witness at the inquest was that the deceased had not got within striking distance of the wires, when he (deceased) fell back upon his companion and soon expired.

There are gentlemen of eminence in the electrical world,

whose names will readily occur to our readers, who lose no opportunity of poohpoohing, before scientific societies and in public lectures of the popular order, the risks of high tension transformer circuits. Indeed, they go so far as to assert that no dangers exist, and that the number of deaths which have been chronicled in America emanated only in the disordered imagination of certain newspaper reporters. These gentlemen are, we imagine, anxious either from interested motives or pure love of science, to see electric lighting progress by leaps and bounds, and probably they think that by blinding themselves and throwing dust in the eyes of the public they are achieving their object; but accidents such as that at Chatham have a marvellously wholesome and sobering effect upon would-be users of the light.

That there is great risk attached to the use of high tension alternating or even continuous currents, every electrician knows, and we have taken many an opportunity of reminding them of it. Why, then, do some people deliberately go out of their way to discount the danger? Would it not be far wiser and decidedly more to their credit to frankly state the nature of the risks to which one may be subjected by the employment of high tension currents, and to define the precautions which are necessary for the users' safety?

The Chatham fatality is not a matter which can be briefly dismissed by a flippant remark that the public on whose premises the electric light is installed should not interfere with the apparatus, for so long as such defects in the supply take place, so long will similar catastrophes happen. A man is not likely to stand idly looking on at a series of sparks or a flame, when he thinks the premises are likely to take fire; his first thought is to beat it out in its incipient stage, and he is not very particular in the excitement of the moment as to what kind of implement he uses to effect his object. The verdict of the jury, which appears on another page, is sensible enough in its way, but it does not go far enough. Transformers must be forbidden inside houses, and must be strictly confined to the supply companies' sub-stations, or to specially constructed apparatus outside the house, and out of the public reach.

The evidence at our command is insufficient to enable us to enter into the matter fully, but what there is seems to point to a want of proper insulation in the transformer. The difficulty of securing reliable insulation in these apparatus has always been one of the chief drawbacks to their safety, and unless we sacrifice efficiency it will probably always be so.

THE CRY AGAINST ELECTROCUTION.

Our emotional contemporary, the *Lancet*, this week again raises its plaintive voice against capital punishment by electricity. It is difficult to understand the attitude of the *Lancet*. We have again and again endeavoured to discover its general consistency in humane matters, but we fail.

The *Daily Chronicle*, too, has assumed a similar tone towards the new American method of exacting the death penalty, but evidently takes its cue from the New York correspondent of "our leading medical journal."

We want to know are our own prisons entirely free from dreadful scenes during the execution of murderers? Apparently, if we judge by only the most recent case, they are not. Mr. Berry is so disgusted with medical interference at the Kirkdale jail, Liverpool, while recently carrying out his duty, that he has just tendered his resignation to the Home Secretary.

Berry states that in a recent case he had arranged for a 3 feet 6 inches drop, and on arriving at the prison, he found that the medical attendant had decided on one of 6 feet 8 inches. The medical officer who, in a private letter bears testimony to Berry's efficiency, insisted on his directions being carried out. As Berry had foreseen, the prisoner was decapitated on the fall of the drop.

Now, let us suppose that the newspaper reporters had had every access to the scaffold, such as, according to the new United States law, they had at the recent execution at Sing Sing prison, would not the "copy," which they would have made out of it, have been at least as highly sensational as that which appeared in the New York papers. The only "sickening" sights at an electrocution (and there must always be such sights when a man is done to death) were apparently those produced by the muscular contractions of a *dead* man.

[The chief doctor said, "Every physician here will agree with me that the subject was dead when the first shock reached him."]

This is horrible, we admit, as death always is, but would it not be more horrible to stand by and see a human being's head wrenched off as was the case at Liverpool the other day? The outcome of some two centuries of practice at hanging a man seems to be that we have attained nothing more humane than the risk of pulling his head off. The outcome of some two years of electrocution is instantaneous death to the subject, followed by a few post-mortem muscular contractions, unaccompanied by mutilation.

We join issue, however, with the *Lancet*, when it condemns the practice of allowing the newspaper men behind the scenes to concert gory copy. If we are to have capital punishment, let it be conducted in the presence of a few selected officials whose only business is to make a report.

THE LOSSES IN THE IRON CORES OF TRANSFORMERS.

The necessity for an accurate determination of the energy dissipated in heating the iron core of an alternating current transformer has become very apparent ever since Mr. Swinburne commenced his energetic campaign on behalf of the "Hedgehog" by drawing attention to the important part that these losses play in determining the all-day efficiency of a transformer; since in an ordinary way this apparatus, when attached to the distributing mains of a supply company, is rarely working at more than half load, and even that load is only on for a few hours, whereas the losses in the iron core are going on continuously throughout the 24 hours. It has been customary to look to the results of Prof. Ewing's experiments on hysteresis to furnish figures for calculating the losses in a transformer due to this cause, although some doubts have been expressed as to whether the results of tests giving the relation between the induction and the magnetising force, when the latter is varied slowly step by step, are applicable to the case of a transformer in which the mag-

netising force is varied rapidly. Prof. Ewing himself showed that for very small changes of magnetising force applied slowly, the corresponding magnetic changes did depend on the speed with which the magnetising force was varied, and several experimenters have found results tending to show that the losses due to rapid cyclic changes are somewhat less than those calculated from the results of step by step tests. Against this possible diminution in the loss when the reversals are made rapidly may be set, however, a probable increase due to the fact that commercial iron is not often equal in quality to the soft annealed wire on which Prof. Ewing experimented; and it is doubtful, therefore, whether the hysteresis loss in a commercial transformer will ever be less than that obtained by calculation from Prof. Ewing's figures.

In all tests on transformers supplied with alternating currents of ordinary frequencies, the iron losses are partly due to hysteresis and partly to eddy currents in the iron, and it is the sum of these two losses that is measured; so that a difficulty arises owing to the necessity of separating the total loss into its two component parts. This is sometimes met by calculating the losses due to eddy currents, and subtracting the figures so obtained from the total losses, and sometimes by testing the transformer at different frequencies and resolving the losses into two parts, one due to hysteresis which varies as the first power of the frequency, and the other due to eddy currents varying as the square of the frequency; this latter method being one which was adopted by Mr. Mordey for determining the hysteresis and eddy current losses in the armature of a continuous current dynamo.

To determine the total losses in the first place, various methods have been employed; for instance, the energy supplied to the transformer has been measured by electrical measuring instruments, but with this method serious errors may occur unless the instruments can be made with no appreciable self-induction, or corrections can be made for the errors in the readings due to this cause; or, again, the rise of temperature of the iron core has been measured by a thermometer, or calculated from the increase of resistance of a wire in the core, and the energy dissipated in the core has then been calculated from the rise of temperature and the specific heat of the iron; but neither of these methods are free from objection. Another method has recently been proposed by Prof. Ewing, which should certainly give more reliable results than any of those already mentioned, but unfortunately it cannot be applied to the ordinary commercial transformer, since it depends on the use of a core built up of iron wire insulated, in such a manner that a current may be passed through the circuit formed by it. For this method two transformers are required, which must be similar in all respects, except that in one of them the primary and secondary windings must be so arranged, that the two halves of each winding will oppose one another, with the result that these windings will produce no magnetic action in the iron core when an alternating current is passed through them; but that, at the same time, the $c^2 R$ losses in the windings of this transformer will be exactly the same as in those of the other, in which the primary and secondary are arranged in the usual manner. The coils of each transformer will be wound up of soft iron wire, cotton covered so that each turn is insulated from its neighbours, and in each core there will be imbedded a thermo-electric junction. The two transformers will be connected together, so that the primary and secondary of one are in series respectively with the primary and secondary of the other, and an alternating current will be passed through the two primaries. Since the same current passes through the windings of each transformer, the difference of temperature, which can be noted when the two thermo-electric junctions are connected in opposition to one another, and in circuit with a galvanometer, will be due to the heating caused by the iron losses in the transformer in which magnetic reversals take place, and it is proposed to balance this heating effect against that caused by passing a continuous current through the iron wire core of the non-active transformer, and to measure the energy dissipated by hysteresis and eddy currents in the one, by the $c^2 R$ loss due to the passage of the continuous current through the iron wire of the other core.

No results obtained by this method have yet been published, and, as already mentioned, the test cannot be made with commercial transformers; but if, by this means, the relation between the actual losses due to rapid reversals of the magnetising force, and those calculated from slow cycle tests on the same iron core can be established, it will then be possible to obtain, by slow cycle tests, the figures for other qualities of iron, and to apply them to calculating the losses in transformers in which the same iron is employed.

Two contributions to the literature of this subject have, however, quite recently been made, the one by Mr. Steinmetz in a paper read before the American Institute of Electrical Engineers in January last, and the other by Mr. Siemens in his paper read last month before the Institution of Electrical Engineers; and it is proposed in the present article to compare the results given in these two papers with one another, and with the figures calculated from Prof. Ewing's slow cycle tests. The method of making the tests differed in the two cases, that adopted by Mr. Steinmetz relying on electrical measuring instruments of the zero reading electro-dynamometer type, the instruments being especially constructed with very low self-induction, and carefully checked at frequent intervals during the tests, and corrections being made for the errors due to self-induction whenever these latter amounted to one or more per cent. of the reading; whilst that adopted by Mr. Siemens was a temperature method, in which the rise of temperature in one of the wires of the iron core was obtained from the increase in its resistance, and the energy calculated (after allowing for loss of heat by radiation and convection by plotting a cooling curve) from the known mass of the iron, its specific heat, and the rise of temperature per second.

Tests were made by Mr. Steinmetz on a small Westinghouse transformer, on a magnetic circuit built up of soft iron plates ·02577 centimetres thick insulated from one another by layers of paper, and on another magnetic circuit built up of iron sheets ·0686 centimetres thick; and in all cases it was found that the results followed very closely the law that the hysteresis loss varied as the (1·6)th power of the induction, a law which Mr. Steinmetz had previously found to give results in close agreement with the figures obtained by Prof. Ewing from his slow cycle tests. In the tests with the Westinghouse transformer, and the thin plate core, it appears to have been assumed that the eddy current losses were so small as to be negligible, and no attempt was

made to separate them out; but in the tests on the thicker plate core, the loss was divided up by comparing the results obtained at different frequencies into two parts, one of which, the hysteresis loss, varied as the 1st power of the frequency, and the other, the eddy current loss, as the 2nd power of the frequency. With regard to the Westinghouse transformer, the results obtained at different frequencies do not point to any appreciable eddy current loss, but with the thin plate core the assumption that these losses were negligible appears to be hardly warranted, as, if the law mentioned above is expressed by the equation $w = \eta B^x$, it was found that the values both of the multiplier η and the power x were greater at high frequencies than at low; so much so, indeed, that Mr. Steinmetz gives an empirical formula for the value of η in terms of the frequency, which makes $\eta = \cdot0026$ at 66 $\sim$, $\eta = \cdot003$ at 100 $\sim$, and $\eta = \cdot0033$ at 133 $\sim$. This being so, a more accurate result would probably have been obtained if the eddy current losses had been separated out in this case, and in the table which is given of the results of the several experiments, a column has been added which shows the eddy current losses in the thin plate core on the assumption that they can be expressed by the equation $w' = A n^2 B^2 t^2$, where A is a constant depending on the resistance of the iron (calculated in this case from the formula given for the eddy current loss in the thicker plates), and n, B, and t are the frequency, induction, and thickness of the plates. The values of η given in the paper when the loss is expressed in ergs and the induction in C.G.S. units vary from ·00241 to ·00333, the corresponding value for the iron experimented on by Prof. Ewing being ·002, thus showing a very wide variation between different qualities of iron.

Mr. Siemens's tests were made on a cable transformer, and the hysteresis loss was obtained by subtracting the calculated eddy current loss from the total loss. In the discussion on the paper, Prof. Fleming drew attention to an error in the calculations of the eddy current loss, and pointed out that if this were corrected, the hysteresis loss might be represented by $\cdot625\, n\, B \times 10^{-7}$ watts per cubic centimetre: that is to say, that the energy dissipated by hysteresis would vary directly as the induction. The wide difference between this result and that arrived at by Mr. Steinmetz, viz., that the hysteresis loss varied as $B^{1\cdot6}$, shows that there is need for further tests, and it is to be hoped that the method proposed by Prof. Ewing will be tried at an early date, and that a series of tests will be made which will enable the law of the hysteresis loss to be stated in such a manner as to leave little doubt as to its accuracy.

In the table at the foot, the results of the various tests referred to have been set side by side, the losses being stated in all cases in watts per cwt. of iron at a frequency of 100 $\sim$, the volume of 1 cwt. of iron having been taken as 6,550 cubic centimetres in each case where the results were originally given per cubic centimetre. The first column gives the value of the maximum induction B, and the other columns the hysteresis loss, w, the eddy current loss, w′, or the total loss, w + w′, the values given on the authority of Prof. Ewing and Mr. Siemens being calculated from their observed results, whilst those given as due to Mr. Steinmetz and Prof. Fleming are calculated from the formulæ suggested by them as expressing in each case the relation between the loss and the induction.

Coast Communication.

In the concluding article on this subject, which appeared in the *Western Morning News*, and in the *Times*, the special commissioner after dealing with the technicalities in the matter of the establishment of communication with lightships, goes on to say, with regard to rock lighthouses:—"It is a fact equally indisputable that there is no insuperable difficulty in so connecting the great majority, if not all, of our rock lighthouses by telegraph cable with the mainland. An eminent engineer, who has large experience in similar work, and is certainly qualified to give an authoritative opinion upon the subject, assured me that if proper measures were taken, the laying and maintenance of a cable to a rock lighthouse need not be a work, as it has been represented, either of considerable cost or of constant trouble. To say that an engineer who has erected towers upon the Wolf and Eddystone could not connect them with the shore by a cable, is about equivalent to speaking of a man who has made a bird cage and cannot put a perch up in it. In the case of the experiment at Fastnet, the steps taken to preserve the cable from injury on the rocks were very primitive in their character, and it is tolerably certain that with better knowledge and more experience the result of the trial would have been different." This is just the opinion that we have again and again expressed in these columns. It is obvious that telegraph engineers, who have had no particular experience in matters connected with lighthouses, would do well to obtain the opinion of those engineers who have, before embarking on the work. The failure of the Fastnet cable would have been discreditable to no one, had every means been taken to secure success; but to carry out such a work, without consulting authorities, and in the usual routine way of laying cables, is simply to court failure, and the failure in such a matter as this, by an important contracting company, is naturally taken by the public as a certain proof that the difficulties are almost insuperable.

Table of Iron Losses.

	Ewing.	Steinmetz.					Siemens.		Fleming.
B.	W.	Westinghouse transformer. w + w′.	Thin plate core, w + w′.	Thin plate core, w′.	Thick plate core, w.	Thick plate core, w′.	Core of wire 1 mm. dia., w.	Core of wire 1 mm. dia., w′.	Core of wire 1 mm. dia., w.
1,000	...	9·95	12·5	0·69	13·8	4·88	39·9	3·3	40·9
2,000	27·5	30·2	37·3	2·76	41·7	19·5	82·9	13·3	81·9
3,000	52·4	57·9	72·0	6·20	79·8	44·0	128	29·9	123
4,000	79·9	91·6	114	11·0	126	78·1	178	53·3	164
5,000	111	131	163	17·2	181	122	226	83·3	205
6,000	144	176	218	24·8	242	176	270	120	246
7,000	181	225	279	33·8	310	239	...	...	286
8 000	226	278	346	44·1	383	313	...	...	327
9,000	275	336	416	55·8	463	396	...	...	368
10,000	327	397	493	68·9	548	488	...	...	409

THE CONDUCTIVITY OF LEAD PEROXIDE.

The question whether peroxide of lead and its hydrate ($H_2 PbO_3$) conduct electricity like the metals or like electrolytes, has recently been investigated by Dr. John Shields, who dates his communication to the *Chemical News*, in which he gives an account of his work, from Leipzig.

A quantity of pure lead peroxide was prepared, according to the method prescribed by Wöhler [*vide Journal für Prakt. Chemie*, xc. p. 383], whilst the hydrate was deposited electrolytically from a solution of sodium lead tartrate on a sheet of platinum.

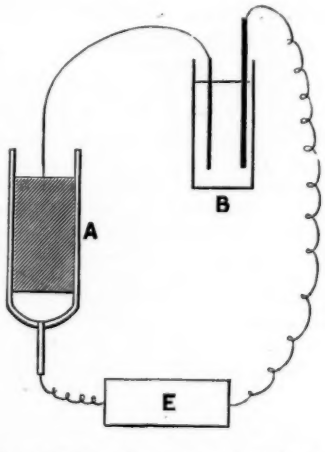
The first method employed in examining into this question of conductivity was the following:—The chemically and electrolytically prepared peroxides were pressed into circular discs, 13·3 mm. in diameter, which were then firmly clamped between two platinum plates connected with a battery. After the current had passed for a considerable time the battery circuit was broken, and at the same moment the plates were placed in connection with a sensitive galvanometer.

Although these experiments were repeated several times, no deflection of the galvanometer could be observed. Now, if either of the peroxides conducted electrolytically, decomposition would have ensued on passing the current of electricity, and, consequently a polarisation current would have been obtained on breaking the battery circuit, and connecting with the galvanometer. As neither of the peroxides gave such a current, it was concluded that both conduct electricity like the metals do.

This result stands in direct opposition to that obtained by Streintz (*vide Wiedermann's Annalen*, xli., p. 104), who found that chemically prepared peroxide of lead conducted like a metal, whilst the hydrated peroxide behaved like an electrolyte.

In order to check the result Dr. Shields determined to repeat the experiments, using the method employed by Streintz himself.

A diagram of the arrangement of the apparatus is given below.



A glass tube, A, is closed at one end with a piece of clean metallic lead or platinum, as the case may be, and into the tube is pressed the substance to be examined. This is connected with dilute sulphuric acid contained in the beaker, B, by means of a moist cotton thread. In the beaker stands a rod of amalgamated zinc. The difference of potential between the zinc and the lead or platinum is measured with the electrometer, E (in this case Ostwald's form of the capillary electrometer was used and the potential difference obtained by compensation).

Now, if the substance contained in A conducts like a metal, the lead may be replaced by platinum or any other metal, and the potential difference will always remain the same. On the other hand, if the substance in A is an electrolyte, a certain difference of potential between zinc and lead will be obtained; and if platinum be substituted for lead another potential difference will be obtained, and so on for all the different metals.

Several tubes were used by Dr. Shields, half of them being closed at one end with freshly-scraped lead and the other half with platinum, and the following results were obtained:—

Chemically prepared peroxide of lead (PbO_2)

Potential difference Zn — Pb = 2·13 volt.
" " Zn — Pt = 2·14 "

Electrolytically peroxide of lead (*i.e.*, the hydrate $H_2 PbO_3$).

I. { Potential difference Zn — Pb = 2·01 volt.
{ " " Zn — Pt = 2·02 "

This sample was thoroughly washed with distilled water and dried in the air.

These experiments confirm the result obtained by the first method of examination. But since it did not agree with the observations of Streintz, a fresh quantity of peroxide was prepared electrolytically; it was washed with water, alcohol, and ether, and then *at once* pressed into the tubes and the measurements made.

Electrolytically prepared peroxide (*i.e.*, the hydrate $H_2 PbO_3$)

II. { Potential difference Zn — Pb = 1·92 volt.
{ " " Zn — Pt = 1·94 "

The potential differences observed by Dr. Shields are in all cases independent of the metal in direct contact with the substance examined, and therefore he comes to the conclusion that peroxide of lead, PbO_2, as well as its hydrate $H_2 PbO_3$, conduct electricity in the same way as the metals.

Dr. Shields also made an approximate determination of the resistance of the peroxide of lead and no change in this was noticed on heating to 115° C.

	C.G.S. units.
Specific resistance of the chemically prepared peroxide	$5{\cdot}59 \times 10^9$
Specific resistance of the electrolytically prepared peroxide	$6{\cdot}78 \times 10^9$

THEFT AND ELECTRICITY.

[FROM OUR OWN CORRESPONDENT.]

It is well known that electricity now plays a very important part in the sphere of theft, in which both the parties concerned, on the one hand the rogues, and on the other the public, which stands on its defence, are engaged in an equally acute manner. A picture of the activity developed in this sphere—at once comprehensive and fascinating—has been recently afforded by a small exhibition of the tools of thieves which has been recently got up at the Polytechnic Society of Berlin, on the occasion of a lecture on "Electric Appliances for the Security of Property."

The burglar who purposes occupying himself with safes, "proof against robbery and fire," requires not merely great bodily strength and technical expertness, but he must be to a certain extent a capitalist, since the appliances which he uses must be very carefully constructed, and require therefore a considerable expenditure. The days in which the burglar could bore a hole with an ordinary centrebit which may then be enlarged with a file, are generally speaking, at an end. The modern equipment of a safe-breaker takes up certainly little space, and can be conveniently stowed in a small travelling bag. The most important instrument, and, at the same time, the fulcrum for most of the other tools, is a carefully wrought compound breaking lever with which a very great force can be exerted. An "advanced" burglar has at his disposal two such crow-bars. At one end of such a bar there is an arrangement which allows of a hammer being attached whilst the other end admits of the insertion of a series of other tools. If it is required to remove the door pillars met with in many safes, a pointed and curved iron is attached with which the pillars may be easily grasped. If they resist this attack a kind of claw is screwed on, and with the help of the crow-bar even the strongest pillar may be burst off. If it is intended to tear away the angle hooks at the corners of the safe, a forceps is fitted into the lever, and if such a lever is applied at each of two corners, by pressing both levers together, even very strong walls may be conveniently forced in and the connections may thus be loosened. Certainly the manufacture of safes has not been standing still, but has entered into a desperate war

with the burglars. The first step has been to manufacture safes which afford no point of attack for claws and pincers, and thus safes have been produced welded into one piece. It has also been attempted to make boring and filing impossible by the use of steel plates which resist every boring tool. But as these plates are so brittle that they can be broken in pieces with a hammer, the steel plates are welded together with plates of wrought iron, and thus the attack with the hammer has been rendered impossible.

On the other hand, the experienced burglar carries with him a melting lamp with which in the course of 10 to 15 minutes he can operate upon ordinary plates so as to produce a hole through which he could creep into the safe. More massive structures afford here, however, considerable resistance, and would require the work of hours.

Still, under the circumstances, it has been considered necessary to devise further security, for which purpose electricity has been called into requisition. An inhabitant of Munich has produced electric safety signals, depending on the well-known principle of thread-contact. The apparatus is placed within the safe and the current is introduced through holes which unfortunately afford new points of attack. M. Berg, the lecturer of the evening, has adopted a different principle of construction. He places his apparatus free and open upon the safe, and exposes, also, the wires connecting it with the signal apparatus in the watchman's room. The advantages of this construction are that, according to the opinion of the Physico-technical Imperial Institute, it is not possible, even for a trained electrical engineer to render the apparatus in any manner inoperative. As soon as the safe is exposed to any agitation, or as a blast flame acts upon the safe (surrounded with conducting wires), or as the circuit is interrupted, the alarm bell is at once set in action and the thief thus betrays his own presence.

PHYSIOLOGICAL OBSERVATIONS AT THE McILVAINE ELECTROCUTION.*

By A. E. KENNELLY.

There are certain physiological facts brought to light in the last electrocution at Sing Sing, N.Y., on the 8th inst., which have a certain importance from a purely physical point of view, especially as this has been the first occasion on which the particulars of the event have been published under the revised legal enactment.

The electrical pressure at the electrodes was determined from a Cardew voltmeter in circuit with a non-inductive resistance. The current passing through the electrodes was observed from a direct reading dead beat ammeter, and the indications of these carefully calibrated instruments afford reliable i ferences as to the resistance of a human body, under definite conditions of surface contact, to an alternating current making some 150 periods per second.

From the official records as already published it would appear that in the first application the pressure at electrodes was maintained at approximately 1,600 volts and the current which commenced at 2·0 ampères steadily increased during the 50 seconds of contact up to 3·1, indicating a resistance between electrodes diminishing from the initial value of 800 ohms to a final value of 516, a reduction during the interval of more than 35 per cent. The electrodes were metal plates in large wooden receptacles nearly filled with tepid salt water, and in which the hands of the criminal were immersed. Judging from the fact that although the skin of the hands was blistered over the areas above the water level that had been wetted by first immersion and then withdrawn, yet the skin that remained immersed was entirely uninjured, it seems reasonable to suppose that no very large proportion of the whole resistance of the body would reside in the integuments at the electrodes.

In the second application 43 seconds later, the pressure was observed to be maintained at approximately 1,500 volts, and the current which passed between the forehead and the calf of the right leg continued at 7·0 ampères during the 36 seconds of contact, indicating a resistance practically steady at 214 ohms during that time. The electrodes were of sponge kept thoroughly wetted with cool salt water and backed by metallic plates, the area covered by each being about 100 sq. cms. Since no blistering took place immediately beneath the head electrode, although some blistering occurred at the other, it would appear that no large proportion of the total resistance existed in the contact areas.

The mean activity developed in heat during the first application was thus 4,080 watts and in the second 10,500 watts, or about 14 E.H.P., this large expenditure of energy accounting for the considerable post mortem temperatures that are stated to have been observed.

The average resistance of the human body between the hands immersed to the wrists in dilute solutions of salt or soda, is often overstated in measurement owing to the vitiating influence of polarisation on observations taken with feeble currents in the Wheatstone bridge. Correct readings can, however, be obtained either by bridge measurement to "immediate false zero" or by the use of large resistances inserted directly in the electrode circuit through a galvanometer so as to employ a higher pressure without pain to the subject and so reduce the influence of the possible 2·5 volts of polarisation counter E.M.F. In either case the mean resistance under these conditions is about 1,000 ohms.

The inference appears to be drawn that the resistance of the body between hands to an alternating pressure of 1,500 volts is only about one-half what it is to continuous pressures of 5 volts or to alternating pressures of 2 or 3 volts, and from the observations above mentioned it would seem that the resistance between forehead and calf is very much lower than between immersed hands. While in conclusion the general belief is further substantiated, that the quantity of current which may pass through the body from a contact with high pressures will entirely depend upon the area and moisture of the contact surfaces, being large with extended and wet surfaces, but perhaps comparatively small for brief contacts on dry and limited surfaces of touch.

* *Electrical Engineer* of New York.

THE ELECTRICAL CONDUCTIVITY OF THE EARTH.

By ROLLO APPLEYARD.

An account of a few tentative experiments on the electrical resistance of the earth may be found in Appendix VI., Vol. II., of Schwendler's "Testing Instructions," 1880 edition, the object of them being to ascertain, if possible, the relation between the variation of the resistance of earth-plates with their size, distance apart, and the conductivity of the material in which they are buried. It was found to be extremely difficult to make accurate measurements, on account of the influence of natural currents between the plates, and other accidental influences not easy to control.

Schwendler points out that the flow of current between two electrodes buried in a conductor of very large dimensions, takes place in peculiar curves, all of which terminate with the electrodes, and that the current density is greatest near the surfaces of contact. Hence the conductivity of the material just around the electrodes must have the greatest effect in altering the resistance between them. By placing, therefore, the plates in a good conducting substance, such as mud saturated with water, or by artificially surrounding each plate by substances of low resistance, such as charcoal, coke, &c., we can most decidedly decrease the resistance between the electrodes.

As the resistance offered by a plate in contact with the ground does not wholly depend upon the average conductivity of the medium, any attempts at measuring this conductivity will be met by the difficulty of eliminating errors due to the nature of the contact material, and of estimating the effective size of the electrodes. These errors will diminish in proportion as the plates are increased in area.

The principal source of mismeasurement feared by Schwendler seems to have been that due to the natural currents, which were, to a great extent, the result of the method he employed for estimating the resistance. In the

tests referred to, the electrodes were on circuit nearly throughout the whole time, and polarisation was the immediate cause of errors.

As the result of a series of experiments, the present writer has shown* that consistent measurements of earth resistances are only possible when the method adopted is such that the plates are on open circuit during the test; and that when a favourable method is employed, not only the *initial* resistance of the plates, but also the *initial* natural E.M.F. between them, can he obtained with a very fair degree of accuracy, so that the main difficulty met by Schwendler is overcome.

Notwithstanding the approximate nature of Schwendler's experiments, however, he was able to bring forward some very significant results. He found that the resistance of an earth-plate, 42 inches × 42 inches, at different parts of India, varies far more than the resistance of an earth-plate in the same locality at different periods; and only at a few places, as for instance at Bellary, does the resistance exceed a certain limit of about 10 ohms. At Raneegunge, where coals prevail in abundance, the resistance of the earth is exceedingly small, scarcely more than half an ohm. He further observes that "if the calculated conductivity is very high we may conclude that our planet at the spot must consist of good conducting substance, and supposing that the methods of measurement are accurate, and that the many accidental influences still inherent could safely be eliminated, the method of measuring the resistance of an earth might give the geologist very valuable information of the kind of strata at the spot where the measurements have been taken."

For the extension of these interesting experiments we must trust to those in charge of testing stations abroad, as they seem to monopolise the use of earth plates.

If two plates have a surface, s, as measured in square centimetres on one side of one of them, and resistance, ρ, between them, in a substance of specific conductivity, k, then, approximately,

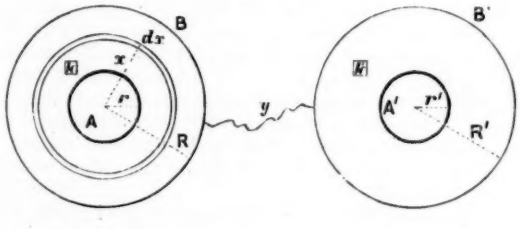
$$k = \frac{1}{\rho \sqrt{\pi s}},$$

or, if we measure the resistance of a single plate, as is usually the case, by taking three plates and determining their resistances two at a time,* and denote by σ the resistance of one of them,

$$k = \frac{2}{\sigma \sqrt{\pi s}}.$$

With a slight development, and a few significant corrections, the following is Schwendler's method of treating the matter:—Suppose a perfectly conducting spherical electrode, A,

FIG. 1.



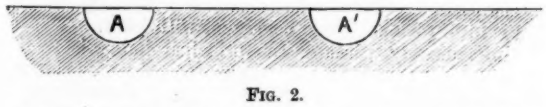


FIG. 2.

of radius, r, to be placed at the middle of a second electrode, B, consisting of a perfectly conducting spherical shell of greater radius, R, and that the space between the two electrodes, A and B, is occupied by a uniformly conducting substance of conductivity, k, then the electrical resistance between the two electrodes can be approximately calculated, if we assume the lines of flow to be normal to the surfaces of the electrodes.

About the common centre of the two electrodes, describe one sphere of radius, x (greater than r but smaller than R), and a second of radius, $x + dx$. Then the resistance of the spherical shell enclosed between x and $x + dx$ is

$$dw = \frac{dx}{4\pi x^2 k}$$

Hence the total resistance between A and B is

$$w = \frac{1}{4\pi k}\int_r^R \frac{dx}{x^2} = \frac{1}{4\pi k}\left(\frac{1}{r} - \frac{1}{R}\right) \qquad (1)$$

Similarly for the concentric spheres, A', B', we have

$$w' = \frac{1}{4\pi k'}\left(\frac{1}{r'} - \frac{1}{R'}\right) \qquad (2)$$

Now connect B to B' by a conductor of resistance y. The total resistance between the inner electrodes, A, A' will be

$$z = w + y + w'$$

Or if, we suppose the outer spheres to become greater and greater, in the limit $R = R_1 = \infty$ and $y = 0$. Putting $k = k'$, equation (1) becomes

$$w = \frac{1}{4\pi k r}\text{; and from (2), } w' = \frac{1}{4\pi k r'}$$

$$\therefore z = w + w' = \frac{1}{4\pi k}\left(\frac{1}{r} + \frac{1}{r'}\right)$$

Further, let the spheres be cut by a plane through their centres. Fig. 2 shows that this will now fairly represent the case of two hemispherical conductors buried near the surface of the earth.

Upon the assumption, which is a very great one, that the lines of flow are still straight, we have for the resistance between A and A'

$$\rho = 2z = \frac{1}{2\pi k}\left(\frac{1}{r} + \frac{1}{r'}\right) \qquad (3)$$

Here ρ represents the resistance between two hemispherical electrodes, A, A', of radius, r, r', respectively, buried at the surface of an infinite uniformly conducting medium of specific conductivity k. When $r = r'$

$$\rho = \frac{1}{\pi k r} \qquad (4)$$

The surface of one of these hemispheres is equal to that of a plate of surface, s, where

$$s = 2\pi r^2$$

But as in practice both sides of the plate are in contact with the earth, the actual dimensions of them as measured on one side of one of them, will be only half this area. Denoting this by s,

$$s = \pi r^2$$

Hence

$$r = \sqrt{\frac{s}{\pi}}$$

Putting this value of r in (4), we have

$$\rho = \frac{1}{\pi k\sqrt{\frac{s}{\pi}}} = \frac{1}{k\sqrt{\pi s}}$$

or,

$$k = \frac{1}{\rho\sqrt{\pi s}}$$

Of course this is only an approximation of the roughest kind, but it shows that the resistance is independent of the distance between the plates, and varies inversely as the square root of their area. Experiments made in Calcutta in 1869 went to prove that the resistance actually is the same at all distances apart, even at very small distances; and that actually the resistance between a pair of plates decreases more slowly than directly with the surface of the plates, and does so apparently proportionally to the square root of their surface area.

The Electric Light at Bournemouth.—The Board of Trade has consented to grant a licence to the Town Council for the lighting of the pier by electricity. No doubt is entertained that this will add greatly to the attractiveness of the Marine Promenade. The Town Council has given permission to the Bournemouth and District Electric Light Company to lay underground mains in several roads in the western and central districts.

* ELECTRICAL REVIEW, December 18th, 1891.

EXCAVATING TUNNELS AND ADITS BY THE ELECTRICAL TRANSFER OF POWER.

[FROM OUR OWN CORRESPONDENT.]

THE process of boring tunnels and adits described below, which has been elaborated by the firm Gœnz and Co., of Budapest, in conjunction with Theodor, Knight von Grasern, a captain of the Austrian Engineers, serves for making underground passages without blasting, and with suitable modifications in the tools and machinery can be applied to every kind of earth, sand, clays, humus, &c., and to every rock which is not too hard, sandstone, marls, clays, shales, coal, &c.

It is distinguished from all former devices for similar purposes by the circumstance that not only the earthwork itself, the breaking up the earth or rock is effected mechanically, but also the shovelling of the mass away into the barrows, trucks, buckets, &c., whereby its working capacity is raised to an extent heretofore unattainable.

The working capacity may be stated at 10 to 20 metres daily, as the work is continuous, excepting small interruptions for oiling, &c., according to the diameter of the tunnel.

The section of the adits, &c., excavated by this process is circular, and the diameter may vary at pleasure from 1·8 metre to 4 metres. The section is worked out evenly by the machine.

In order in the newly bored parts of an adit in soft earth to prevent the collapse of the sides or the detachment of single fragments, it is provisionally masked with sheet-iron held in its place by supports of U or L iron. As the work advances, this provisional coating is superseded, according to local circumstances and to the purpose of the tunnel, by a lining of masonry. This lining may be modified in its structure and materials. In adits in solid rock or firm earth, the provisional sheet-iron lining is chiefly unnecessary, and a provisional structure is merely introduced for the continuous removal of the excavated material and for introducing the current as described below.

The removal of the excavated material is effected by means of a transport-structure built into the boring machine itself and worked by it. The material is flung into small travelling vessels, "dogs," which roll on an endless flying line and which empty it into larger or normal "dogs" or lorries. We call this line "flying" because it consists merely of a U iron turned upwards upon which there rests two rollers from which the invertable receptacle is suspended.

The continuity of the work is connected with the length of the train of lorries, or "dogs," which serves to convey away the excavated matter. As often as such a train is fully loaded a short pause must ensue during which the loaded train is run out of the tunnel and an empty train is introduced in its stead.

This pause is used for bringing up new materials for the sides and roof of the excavation.

The boring machine is constructed differently according to the diameter of the tunnel, the kind of earth or rock, &c.

The principle of construction is as follows :—

A horizontal shaft placed in the central axis of the tunnel bears at its first end a central borer, the dimensions and form of which are regulated according to the material to be excavated. Behind this borer there is fixed upon the shaft a nave with a number of radiating arms supporting a certain number of cast steel fangs which, as the shaft revolves and the machine advances, cut circular furrows in the face of the adit from 10 to 20 millimetres in width and from 50 to 100 millimetres in depth. Between there remain portions of 20 to 40 millimetres in width, which, as the machine advances further, are pressed off by special appendages and fall to the ground.

The rock is therefore not crushed but broken up into fragments about the size of a nut. Hence comparatively little power is required to work the machine. This is the cause of the very high duty performed by the machine.

The machine is propelled by an electromotor which is placed in a wrought-iron or cast-iron frame along with the boring shaft and its appendages. The transmission of power is effected by means of toothed steels into which there is introduced a friction coupling, so that if the ploughs encounter a hindrance the motor is released and the strain on the machinery is reduced, and any excessive use of current is prevented.

According to the texture and hardness of the rock to be perforated, the boring shaft receives more or less rotatory speed. In order that the wear and tear of all the ploughs may be approximately equal, they must have an approximately equal cutting speed. This is effected in the larger machines by having instead of one boring "star" (*i.e.*, star-shaped group of arms), several such, and propelling them with different angular velocities. In addition, the ploughs are fixed in several rows in such a manner that two to four of them work in each furrow. In this manner the work to be performed is distributed over many points and there is less fear of the steel tools becoming heated. The number of the ploughs to be attached to each "boring star" is so arranged that approximately the same work may devolve upon all. As the boring stars are fixed concentrically upon the same shaft, but make different numbers of rotations, one or two stars are fixed upon sheathings placed over the boring shaft, which receive their power from special intermediate shafts independently of the main boring shaft.

(To be continued.)

REVIEWS.

Treatise on Industrial Photometry especially applied to Electric Lighting. By A. PALAZ. Paris: G. Carré. (*Traité de Photometrie Industrielle spéciale ment appliquée a l'Eclairage Electrique*).

So long as artificial light was produced by the consumer in his own premises photometry was simply a question for the physicist in his laboratory. Since a public supply of light has been entrusted to public companies, the control of such light, becomes a public question interesting to every consumer. It needs no demonstration that if a company obtains the monopoly of the supply of any necessary, such as gas or water, it "plays such audacious tricks before high Heaven" as makes the public groan. Hence, especially where a town or a parish does not furnish its own gas, gas-inspectors and gas-testers have become indispensable, and photometry now takes rank as an important department of the industrial arts.

It is a somewhat remarkable fact that though gas companies have been flourishing in Great Britain quite as long as in any other country, and have been not more conspicuous for the purity of their product and the probity of their dealings than have their foreign colleagues, the appliances for determining the value of the light have been devised by foreigners, as the reader may at once perceive from an examination of the table of contents. This fact is perhaps due to the tardiness of our governments to become convinced of the necessity of keeping a watchful eye on the doings of companies.

As is very clearly and fully expounded in this work, photometry involves not merely the possession of an instrument for measuring the intensity of light, but of a standard of comparison. This standard should be convenient, uniform, not subject to change, and consistent with itself.

Unfortunately, perhaps, the principal industrial nations have not been able to agree upon some common standard. France has fixed upon the Carcel lamp; this source of light differs from the ordinary Argand lamp merely in the fact that there is a special arrangement to ensure a constant and uniform supply of oil to that point of the wick where the combustion is actually going on.

The intensity of the light depends on a variety of conditions which have been carefully studied by Audoin and Bérard, such as the height of the wick above the socket, the texture of the wick, and the height of the contracted part of the glass chimney. A further condition which they do not seem to have regarded and to which even Orova seems to ascribe little importance, is the uniform purity of the colza oil used for feeding the lamp. The generality of French physicists consider that the Carcel is superior to standard candles, whilst on the other hand Mr. Hartley objects that the lamp requires very

minute attention, among other points the employment of a fresh wick whenever it is used.

A more widely used standard or rather set of standards—for it exists in four modifications—is the normal candle. There is the stearine candle, L'Etoile, used in France along with the Carcel, the London standard spermaceti candle employed in Great Britain and the United States, the normal paraffine candle used in Germany and Austria, and the Munich stearine candle.

A decimal candle, the twentieth part of the absolute platinum unit, was proposed at the Congress of Electricians in 1889. Concerning these normal candles opinions differ; Schwendler alleges that the intensity of the London spermaceti candle may vary by as much as 50 per cent. whilst Krüss found that by careful management its luminous intensity does not vary more than 5 per cent. The author explains the circumstances which have a modifying action upon the intensity of the light, especially the height of the wick and the steadiness of the air. From the figures quoted it appears that the constancy of the light given by such candles leaves much to be desired.

Petroleum lamps are considered to have decided advantages as standards over the fatty oils.

A new departure in standards has been made by Von Hefner-Alteneck, who proposes a lamp burning acetate of amyl. This standard has merely an advantage in its constancy, as its variations do not reach 1 per cent. Its luminous intensity is too low and its flame is too rich in the red rays; hence it is not well suited for measuring the intensity of arc lights. It is now found that the nearer the standard approximates in colour to the light to be measured the more accurate is the determination.

Passing over the pentane standard proposed by Vernon Harcourt, we come to the absolute standard of Violle, the quantity of light emitted by a given surface of melted platinum. This standard is absolutely invariable, but it is too expensive and too complicated for common use, and hence it serves in practice merely for keeping a control of the other standards. A Violle unit = 2·08 Carcel, 16·4 German normal candles, 18·5 English candles and 18·9 Hefner-Alteneck lamps.

A very interesting chapter touches upon personal errors. It might be expected that all persons would not be equally sensitive to differences in the intensity of light. But the two eyes of one and the same person are not always equally sensitive. Out of 10 persons compared the right eye was the more sensitive in nine cases and the left eye in one. Observations are more troublesome, but much more certain if they are made with a single eye only, the other being covered.

We do not see any discussion of the possible influence of colour blindness in an observer. Where the lights under comparison differ in colour we might expect that a colour-blind person would obtain results different from those of a person with normal vision.

In one respect the electric light stands less in need of supervision than does gas, which may give a poorer light in consequence of the presence of carbon monoxide, free hydrogen, and of a relative preponderance of the light hydrocarbons. But, on the other hand, electric lamps have the disadvantage of radiating out light unequally in different directions. Hence there results a difficulty in their measurement. In a public lamp we want the greatest proportion of light sent out horizontally or somewhat descending, whilst the arc light tends to throw its maximum of light upwards, where it is not wanted.

The author insists on the importance of a material other than carbon for the production of light. The luminosity of all our artificial lights (always excepting the magnesium light) is produced by the incandescence of carbon. It is, therefore, important to find some substance which at the same temperature may emit a much more considerable proportion of light. Some approach in this direction is made by incandescent magnesium, which gives a light much more closely resembling that of the sun than does any other source of artificial light.

A brief reference is here made to the experiments of Tesla, who has succeeded in rendering practical lamps based on the principle of Geissler's tubes.

Whilst compelled here to close our survey of this interesting subject we must say that M. Palaz, whilst doing full justice to the photometry of the past and the present, has thrown out valuable suggestions for the future.

Secondary Batteries. By J. T. NIBLETT. London: Biggs and Co., Salisbury Court, Fleet Street.

This handy volume of 267 pages, containing 94 good illustrations, is exactly what it professes to be: "A description of the modern apparatus for the storage of electrical energy." It is neither a scientific treatise on this special subject, nor a mere register of patent specifications; it takes a medium place of great utility by giving practical information on the construction of many different types of secondary batteries. Mr. Niblett writes well, he knows what he is writing about, and he gives much useful data on the capacity, weight and efficiency of various cells; information which can only be obtained by a tedious search through a lot of English and foreign literature. The author does not aim at originality, nor does he criticise the figures of results given by different experimenters or makers of accumulators; indeed, it would be difficult to comment upon such figures, considering the variety of results that may be obtained from some batteries according to their age and treatment. The appendix contains paragraphs on such subjects as "Lead and its impurities;" "Test for copper and silver in lead;" "Oxides of lead;" "Prevention of lead poisoning;" "Sulphuric acid;" also useful tables. Experts as well as students will find this a handy book of reference.

A Manual of Physics; being an Introduction to the Study of Physical Science. By WILLIAM PEDDIE, D.Sc., F.R.S.E., Assistant to the Professor of Natural Philosophy in the University of Edinburgh. London: Baillière, Tindall and Cox, 20 and 21, King William Street, Strand.

It is a little difficult to see the value of this work, which is stated to be a review of the elements of the whole subject. Practically the book may be said to be an attempt to work together in one volume a condensation of various modern advanced treatises on the various physical sciences. To a great extent the writer has succeeded in his aim, but to a student the book, as it stands, will be of little use unless he also studies more complete works on the various subjects. The sub-title of the book, viz., "An *introduction* to the study of physical science," is we think misleading, as, although, no doubt etymologically correct, it does not express the generally understood idea of "introduction," any more than the term "elementary" does; the latter term, by the way, is continually used in a misleading way.

Journal of the Institution of Electrical Engineers; No. 95. London: E. & F. N. Spon, 125, Strand.

The chief contents of this number are as follows:—"Description of the standard volt and ampèremeter used at the Ferry Works, Thames Ditton," by Captain H. R. Sankey and F. V. Andersen; "On the specification of insulated conductors for electric lighting and other purposes," by W. H. Preece.

A Pocket-Book of Electrical Rules and Tables. By J. MUNRO and A JAMIESON. Eighth edition, revised and enlarged. London: Charles Griffin and Company, Limited, 12, Exeter Street, Strand.

In this new edition a considerable increase in size is noticeable, the pages now reaching 677. The original matter has been to a great extent re-arranged and a new index compiled. Amongst the more important additions are the following:—Extracts from the Committee's Report to the Board of Trade on "Standards for the Measurement of Electricity;" Conversion Tables for facilitating calculations in British and French Measures; details, with figures, of Sir William Thomson's latest forms of multicellular and other electrostatic voltmeters; details, with figures, of Messrs. Siemens Brothers' current and pressure dynamometers, as well as their portable testing set for measuring the copper and insulation resistances of electric light cables and wires; details, with figures, of Crompton's potentiometer testing arrangement for measuring widely-different ranges of voltage and currents; details, with figures, of Ferranti's meters and cables; a new section on the testing of lamps, electric light and power cables and circuits, &c.; Conversion Tables of

ampères and volts (from 1 to 700 ampéres and 45 to 3,000 volts) into watts and into horse-powers for facilitating the determination of the power developed or spent in electric light and power installations; a table of the current required for Sunbeam lamps; additional electric light tables for standard leads, &c. It will be seen that all these additions very considerably add to the value of the book, and it is difficult to see to what further extent matter can be included without adding inconveniently to the bulk of the same.

Modern Practice of the Electric Telegraph. By F. L. Pope. 14th Edition, re-written and enlarged. London: Sampson, Low, Marston & Co.

The number of editions through which this work has passed is an accurate guarantee of its worth and of the favour in which it is held on the other side of the Atlantic. We have before us a second edition published in 1869, and the contrast between the two editions is very marked; at the same time the book has preserved its practical character to which mainly no doubt it has owed its success. The book now consists of 10 chapters as follows:—I. Introductory; II. and III. Sources of Electricity; IV. Theory of Quantitative Measurement; V. The Laws and Conditions of Electrical Action; VI. The Laws of Electro-Magnetism; VII. Telegraphic Circuits; VIII. Equipment of American Telegraph Lines; IX. Testing Telegraph Lines; X. Hints to Learners. Excellent as the book is it is hardly one which is likely to be of material value to English readers, as it deals almost exclusively with systems which are peculiar to America.

Hints on Chip Carving. By Eleanor Rowe. The School of Art Wood Carving, City and Guilds Institute, Exhibition Road. London: Sutton, Drowlez & Co., 11, Ludgate Hill, E.C.

To those interested in carving work this little manual will be most useful. As a recreation or as a training for the hand and eye carving may be strongly recommended; it is by no means difficult to attain expertness in the art, and those who have taken to it do not regret having done so.

LONDON COUNTY COUNCIL.

The following report of the Parliamentary Committee was submitted at a recent meeting.

Petitions against Bills.

The council having adopted our report on Tuesday last recommending that petitions should be presented against the Bills named, and for the purposes specified therein, we have now to report that we have settled the terms of the various petitions, and have embodied in those relating to underground railway undertakings the addition decided on by the council with regard to uniformity of gauge, and the acquisition by the companies of easement rights of tunnelling. We are in hopes that it will be unnecessary to present all the petitions in consequence of some of the various companies arranging terms; but, as it is necessary to be prepared with petitions, we recommend that the council do authorise the seal to be affixed to petitions against the following Bills, viz.:—Baker Street and Waterloo Railway; Central London Railway; City and South London Railway; Great Northern and City Railway; Hampstead, St. Pancras and Charing Cross Railway; Waterloo and City Railway; Ward Electrical Car Company.

National Telephone Company.—New Telephone Company.

These two Bills may be conveniently considered together. The Bill of the National Telephone Company is practically a repetition of the Bills which they have introduced in several previous sessions, which have been abandoned in consequence of the opposition which they have caused. The Bill will give considerable powers of interfering with streets and roads in the County of London, and is so framed as to leave it doubtful to what extent, if any, the proposed operations would be subject to any control by the council. The object of the New Telephone Company's Bill is to incorporate as a company, subject to statutory powers and obligations, a company which now exists under the Companies Act of 1862, and is one of the companies licensed by the Post Office, but which is not as yet doing practical work in London.

We have consulted the Highways Committee and are advised by them with regard to both Bills that the approval of the council should be required before the execution of any works in the public streets, and the companies should be required, before compulsory powers are given over any land against the wish of the owner and occupier, to show that no convenient alternative route exists. The proposal to lay telephone wires in the conduits of electric lighting companies should be opposed; clauses should be inserted for protection of the council works; the company's works should be subject to the provisions of any by-laws made under the Overhead Wires Act, 1891; the conferring of power on the company to make by-laws should be opposed; and powers of control and supervision should be conferred upon the council. Further, where any works of the company are in a street in which the council has or shall have a subway, the company's mains should be laid in the subway and rent be paid, and all works should be subject to any by-laws under the Overhead Wires Act, 1891.

It is desirable that steps should be taken to secure the insertion of the necessary clauses, and we recommend—"That petitions be presented against the Bills of the National Telephone Company and the New Telephone Company, and that the council do authorise the sealing of the petitions when ready."

The report of the Highways Committee has the following:—

Notices under Electric Lighting Acts and Orders.

We have considered a notice, dated January 9th, 1892, from the St. James and Pall Mall Electric Lighting Company, of intention to lay mains, consisting of Siemens's armoured cables, in Beak Street and Carnaby Street with two crossings in the latter (1 plan). The proposed works are similar to those of this company previously approved by the council; and we recommend that the sanction of the council be given to the works referred to in the notice dated January 9th, 1892, of the St. James and Pall Mall Electric Lighting Company, upon condition that the company do give two days' notice to the council's chief engineer before commencing the works.

We have also to report the receipt of the following notice, given in accordance with the resolution of the council to accept four days (instead of one month's) notice in respect of the laying of service lines from mains already laid from the Electricity Supply Corporation, February, 3rd, 1892, to the "Welsh Harp" public-house, Chandos Street; from the St. James and Pall Mall Electric Lighting Company; February 8th, 1892, to 199, Piccadilly and 44, Pall Mall; February 11th, 1892, to 215, Piccadilly; from the London Electric Supply Corporation, February 9th, 1892, to 40, Strand; the "Fountain" public-house, Borough High Street, and 38, Dover Street.

The Highways Committee submitted the following report:—

Subways—Queen Victoria Street and Charing Cross Road.

We have considered applications from the General Post Office for permission to place an additional four-wire cable in the subway in Queen Victoria Street from the eastern end to Blackfriars, and another four-wire cable in Charing Cross Road subway from the north end to Cambridge Circus. The council has recently entered into an agreement with the Postmaster-General with reference to the use of the subways by the department; and we recommend that, subject to the provisions of the agreement between the Postmaster-General and the council with reference to the use of the council's subways, permission be given to the placing by the Post Office Telegraph Department of a four-wire cable in the Queen Victoria Street subway and of a four-wire cable in the Charing Cross Road subway, between the points mentioned in the application.

Electric Lighting—Applications for Provisional Orders, 1892.

We reported on February 2nd that we had submitted to the Board of Trade certain amendments in the model order (form No. IV.) which the board proposed to adopt for use in cases where the local authorities apply for powers under the Electric Lighting Acts, four of such applications, which we then specified, having been made this year. The principal of these amendments have been adopted by the Board of Trade; and, in our opinion, it is not necessary to press for the remainder, except that, with a view of the council having full information as to the electric lighting works in London, the undertakers shall give notice to the council of all new works. We have directed that the Board of Trade shall be informed to this effect; and we recommend that the course taken by us be approved by the council.

Notices under Electric Lighting Acts and Orders.

We have considered a notice, dated February 18th, 1892, from the Notting Hill Electric Lighting Company, of intention to lay mains in Campden Hill Road, Observatory Avenue, Upper Phillimore Gardens, Holland Walk and Street, Duchess of Bedford's Walk (part of), Durham Villas, Argyll Road, and Essex Villas. This relates to an important extension of the company's system near Holland House. The mains are to be laid principally in 15-inch culvert, with however three lengths of 24-inch culvert; but it is intended that where it is found that there is not sufficient room for these culverts a number of 2-inch pipes shall be substituted. We see no reason for objection to the proposed works, and therefore recommend that the sanction of the council be given to the works referred to in the notice, dated February 18th, 1892, of the Notting Hill Electric Lighting Company, upon condition that the company do give two days' notice to the council's chief engineer before commencing the work; that the cover stones of the culverts under 20 inches wide shall be not less than 2 inches thick, and of the wider culverts not less than 2½ inches; and that where the culvert crosses the carriageway there shall be at least 9 inches' thickness of Portland cement concrete above the cover stones of the culvert in addition to the road material.

We have also considered a notice, dated February 19th, 1892, from the House-to-House Electric Light Supply Company, of intention to lay mains in The Grove, Boltons, from Old Brompton Road to Tregunter Road. The proposed works are of the same character as those of this company previously approved by the council, and we recommend that the sanction of the council be given to the works referred to in

the notice, dated February 19th, 1892, of the House-to-House Electric Light Supply Company, upon condition that the company do give two days' notice to the council's chief engineer before commencing the work; that no pipes of a larger diameter than 6 inches shall be used; that the street boxes shall be of the pattern approved by the council; and that as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, the two insulated from each other as far as practicable, and that the outer cover shall be efficiently connected with earth.

A notice, dated February 23rd, 1892, has been given by the Electric Installation and Maintenance Company of intention to lay mains for the Crystal Palace District Electric Supply Company in Sydenham Hill Road and Avenue, Wells Road, Springfield Road, Jew's Walk, High Street, Kirkdale, West Hill, Crystal Palace Park Road, Lawrie Park Road and Gardens, Border Road and Crescent, Westwood Road, the Private Road, Anerley Road and Westow Hill. The proposed works are objectionable in many respects, and, moreover, the notice stated that it was intended to commence the works on March 8th, instead of at the expiration of one month as required by the order. In the circumstances we recommend that the council do formally disapprove of the works referred to in the notice, dated February 23rd, 1892, of the Electric Installation and Maintenance Company.

The St. James's and Pall Mall Electric Lighting Company has given a notice, dated February 23rd, 1892, of intention to lay mains in Coventry Street (part of), Rupert Street, and the west side of Wardour Street. It is proposed to lay insulated cables in pipes or bitumen conduits, or, where there is found sufficient room, to lay bare copper in Crompton conduits. Having given careful consideration to what is proposed, we recommend that the sanction of the council be given to the works referred to in the notice, dated February 23rd, 1892, of the St. James's and Pall Mall Electric Lighting Company, upon condition that detailed drawings of the proposed works be submitted to and approved by the council's chief engineer; and that when such approval shall have been given, the company do give him two days' notice before commencing the works.

We have also to report the receipt of the following notices, given in accordance with the resolution of the council to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid.

From the St. James and Pall Mall Electric Lighting Company:—February 12th, 1892, to 17, Piccadilly and 19, Clifford Street; February 13th, 1892, to 114, Regent Street; February 16th, 1892, to the Café Monico, Piccadilly Circus; February 19th, 1892, to 21, King Street; February 22nd, 1892, to 78, Savile Row.

From the House-to-House Electric Light Supply Company:—February 12th, 1892, to 6, Sussex Place, 46, Cranley Gardens, and Wetherby Mansions, Earl's Court Road.

From the London Electric Supply Corporation:—February 18th, 1892, to the Pantheon, Oxford Street, and 299, Borough High Street.

From the Electricity Supply Corporation:—February 18th, 1892, to the Lyric Agency, Leicester Square; February 19th, 1892, to 446, Strand and 16, James Street, Haymarket; February 25th, 1892, to the "Prince's Head" public house, Buckingham Street.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

OIL AS AN INSULATOR (illustrated by experiments). By Prof. D. E. HUGHES, F.R.S., past-president. (*Announced for reading yesterday.*)

At our last meeting, Mr. Preece kindly gave me credit for being the first to propose the use of oil as an insulator for wires conveying an electric current; and in accordance with a suggestion on his part, I should like to state upon what grounds I can fairly be considered to be the first to urge upon the electrical world the use of hydrocarbon oils, such as petroleum and rosin oil, for this purpose.

In 1858 universal regret was felt on the failure of the insulation of the first Atlantic cable. From the first successful laying of this cable the insulation gradually became worse, until in a few days all signals failed. The cause of this was supposed to be due to minute flaws in the gutta-percha during its manufacture, which became worse by submersion, or that lightning, or the intense currents then used for the Whitehouse induction coil, punctured the cable at several points.

It appeared to me (from some old experiments of mine) that what we needed was some form of insulation that possessed self-restoring powers, so that, if punctured by lightning, or our ordinary working currents, the puncture should be closed by some simpler process than having to take up a portion of the cable.

I thought that Nature showed us the way in which she restores punctures and mechanical injuries to all living objects. This is done by a flow of liquid sap to plants, or blood in animals; for if we make an incision in the bark of a tree, the sap flows out and hardens in contact with air; if we cut our fingers, blood flows out and heals the wound. Therefore, I thought that if I could enclose in a cable an insulating self-restoring medium, the cable would not become dead at the first, or even after innumerable punctures. To carry out this object it seemed to me that a thick insulating oil, enclosed between the wire and its outer skin, would perfectly fulfil the conditions required.

Faraday had shown some years previously that oil of turpentine had a high insulating property, and this gave me great hopes that I should find, by experimenting with numerous samples of oil, the kind and quality desired for my purpose. Therefore, I at once commenced a long series of experiments in order to find the best kind of oil and the most suitable form of cable to carry out this idea.

Knowing that I could not fairly test these oils, or a short length of cable, by our ordinary voltaic currents, I had recourse to the very high potential currents given by the ordinary frictional static electric machine. The method used was this: I charged a battery of Leyden jars to a known degree, which was indicated upon the Leyden jars by a Peltier electrometer; these jars, when charged, were put in communication with the short piece of the cable to be tested, the outside of which was coated with tinfoil, or placed in water connected with earth, and exterior of the Leyden jars. By this means, if the insulation of the few inches of cable was bad, the Leyden jars would instantly be discharged through the defective insulation; but if the insulation was comparatively perfect, the time of discharge of the electrometer was a correct measure of its insulating properties. Of course this method rquired that the Leyden jars should be perfectly insulated and hold their full charge for at least one hour when not discharging through a defective cable.

On making preliminary experiments on several samples of gutta-percha and India-rubber coated wires, I found a marked difference in each variety; but as these differences were of a constant character for each sample, it was easy to tell which of these had the highest insulating property.

These experiments showed me that if I wished to arrive at the true value of an insulating oil, I must make the experiments by a method by which the result should be entirely free from any interior or exterior coating. For this I took two small flat circular discs, one inch in diameter, which could be immersed in oil, and by an insulated adjustable screw I could compare the striking distance of these discs in air, compared with the same when immersed in oil, and could also observe the time required for a complete discharge of the Leyden jars through this medium.

On testing numerous samples of different oils, I found not only a great difference in the species of oil, but also a great difference in different samples of the same oil; consequently a table giving the results on different oils might be misleading, as a sample of superior quality of a certain oil (although inferior in many other samples) might give higher results than a badly selected sample of a really superior oil.

The only difficulty as regards rosin oil is one of manufacture, or, rather, of finding, and teaching the makers, the quality of oil best suited for the purpose; for I found, on obtaining samples of this oil from different makers, that a great difference existed as regards their insulating properties, ranging from worse than castor oil up to a degree superior to gutta-percha; and this is true of most oils; consequently, before using any oil, its quality as an insulator should be thoroughly known by constant electrical tests.

In selecting oil of high insulating quality, we must also have regard to the purpose for which it is to be used. Thus, as a self-restoring medium having very quick action, for condensers, transformers, or coils so closely wound as to be difficult for a thick oil to penetrate, a thin rosin oil, such as rosin spirit, might be best; but for cables and underground wires I found thick pure rosin oil best, because it was not only superior as an insulator, but it would not escape too rapidly at any large puncture.

Experiments were also carried on at the same time to observe the effect of any given oil on thin sheets of gutta-percha, India-rubber, &c. These were immersed in separate vases of different oils: they were weighed before and after prolonged immersion; the result being that some oils were found to be injurious to gutta-percha, and almost all, with the exception of castor oil, were more or less destructive to India-rubber.

I found, after numerous experiments, that pure rosin oil gave the highest insulation of all, for a spark that would pierce a given thickness of gutta-percha would utterly fail to pierce the same thickness of rosin oil; whilst, if the gutta-percha was pierced, its insulation was destroyed and could not be easily restored to its former condition; on the other hand, if by accident the rosin oil was pierced, it, by its own mobility, at once restored the insulation to its original state. Rosin oil, at the same time, had a preservative effect upon gutta-percha, for the sheets immersed in this oil had become slightly increased in weight, showing that it had penetrated into the pores of the gutta-percha; at the same time it was stiffer and tougher than before immersion. I will now show you an actual specimen of this fluid cable, cut off from a specimen one mile in length, made by the Gutta-Percha Company 33 years since. You will observe that the gutta-percha has absorbed during that time a large proportion of the oil, and that the gutta-percha is now, after 33 years' exposure to the air, apparently as good an insulator as when first made.

Experiments were now made as to the value of rosin oil when employed as the sole insulator of an electric cable. For this purpose, a short length of copper wire (say 1 foot) was coated, first, by being wound by well-dried cotton or hemp, or, better still, by a string wound round in wide open spirals, in order that the oil should penetrate as freely everywhere as possible; this was afterwards drawn into a small lead tube filled with rosin oil: thus the string or fibrous covering on the wire was simply to keep the wire concentric, so as to prevent its touching any part of the exterior tube without some separation of oil or oil-saturated fibre. It will be seen that these tests were identical, both as to form and material, in their essential points, with those patented by Mr. David Brooks, of Philadelphia, some fifteen years later; but as these are clearly described in my patent of January 11th, 1859, there can be no question of priority in this respect, though no doubt many improvements suggested by practical experience in the mode of laying and manufacture are original with Mr. Brooks.

The insulation of this form of cable was not quite as high as solid gutta-percha, due to the fibre not being as good an insulator as the enclosed oil, but its mechanical powers of self-restoration and durability seemed to me to more than counterbalance its slightly less

insulating power, for even with gutta-percha there are questions of strength and durability which ought never to be lost sight of in favour of a temporary high insulation; and I think that when the value of fluid insulation is more thoroughly known, especially for currents of high potential, it will be more generally used than at present, particularly as there are now no valid patent rights to interfere.

I again repeated these experiments, using a thinly covered gutta-percha wire for the inner conductor, drawn into a gutta-percha tube full of rosin oil; this gave me very high insulation—so much so, that I tried a bare copper wire in the gutta-percha tube alone, without any rosin oil; this, to my surprise, gave a far higher insulation than the best gutta-percha-covered wires as supplied to me by the Gutta-Percha Company. This surprised me very much, as the tubes, which I bought at an ordinary retail shop, were known to be of an inferior quality of gutta-percha. I found afterwards that this difference was due to the tubes having been long made, and kept in stock: they had gradually dried, and were free from combined moisture absorbed during their manufacture. I proved this by taking some newly manufactured gutta-percha, and heating it gradually for a length of time sufficient to drive off its moisture: this when modelled on a wire, so as to form a cable, gave precisely the same degree of high insulation as the old tubes that I had purchased elsewhere.

I do not believe that the mechanical quality of the gutta-percha was improved by this operation; most likely it would have soon become brittle, for humidity, or an essential oil, seems necessary to its life and mechanical qualities.

I told Mr. Chartterton and Mr. Willoughby Smith, of the Gutta-Percha Company, of these results, and urged upon them the necessity of well drying the gutta-percha, and of manufacturing their cables, if possible, without constantly macerating it in water. I am not aware that my remarks had any effect, but this I remember—that in a few weeks after, they gave me a sample, which they called "special gutta-percha," which certainly had as good insulating qualities as my dried gutta-percha.

As I have already said, my main object being to produce a self-restoring insulation for cables and underground wires, I found that a thin fluid, such as rosin spirit or petroleum, might be objectionable, as at the point of fracture or puncture the fluid might escape with so great a rapidity as to be somewhat costly in its maintenance; but by employing a thick, heavy, insulating oil, whose rate of flow would be small, this would displace any water in the puncture, provided that there was a slight head pressure given to the oil at a reservoir at certain landing stations: then it would answer all practicable purposes. For this I preferred rosin oil, which is already a thick, viscid oil, and can be made more so by the addition of solid rosin dissolved in it, or by the addition of palm oil residue, which has a remarkable property of thickening rosin oil.

In order to satisfy those who might object to even a very small leakage of oil at the puncture, I made several compounds of rosin oil, mentioned in my patent, that should harden when in contact with water, and thus prevent any waste of oil at the fault or puncture.

The static charge which I used was of high potential; the sparking distance in air, of the charge used, was about 1 inch, and it showed the remarkable insulation of rosin oil when $\frac{1}{64}$th of an inch separation would effectually prevent such a spark passing through it. After having found this high insulating property of rosin oil, I coated all my Leyden jars, and all parts where I desired high insulation with it, and by this means I was enabled to retain a full charge of the Leyden jars for several hours in an atmosphere full of humidity.

They have lately proved the value of oil insulation in Frankfort by the use of oil in transformers of 20,000 volts, and I am convinced that in all cases where we need a high insulation, together with the power of self-restoration, it can only be found in fluid insulators. It is useful in every case where it can be applied; it is far cheaper than gutta-percha, and I have no doubt that it will soon be used for insulation in condensers as well as transformers. Mr. Nikola Tesla, in his late charming lecture, spoke highly of the use of oil in his transformers, saying that it not only gave a perfect insulation, but had the power of restoring the insulation whenever pierced or punctured, as he believed his coils were at least several times every day.

I remarked during these experiments that, no matter how high the potential, the amount of leakage was equal in time, either with a high or low charge of the Leyden jars; that is to say, when the Leyden jars were discharging at a slow rate through a good insulator, the time of falling of the electrometer through any given number of degrees was very equal throughout its whole range from 200,000 to 1,000 volts.

Being desirous of repeating this evening some of my old experiments, I applied to Mr. W. H. Preece for some of the best samples of gutta-percha covered wires as used by the Post Office, and which he has most willingly sent me. I also applied to Mr. James Wimshurst, the inventor of his remarkable static electric machine, who at once most kindly consented to lend the machine, and also design an arrangement by means of which we could show to those at a distance the different distances of the sparking through oil compared with air.

On testing this apparatus with oil, it seemed to show that the value of oil as an insulator increased both with the potential of the charge and also with the rapidity of alternations, for when the experiments were made by an impulsive rush so as to have the greatest number of oscillations per second—say 1,000,000—then even the poorest oil, such as castor oil, showed marked superiority over air or gutta-percha. This confirms the advantage of oil, and its value in connection with the rapid alternating high voltage currents used in our transformers of to-day.

The experiments which we hope to repeat this evening have already shown us that a spark, or charge, from a Leyden jar, which would easily pierce 4 inches of air, will not pierce $\frac{1}{10}$th-inch of rosin oil, proving that oil, when resisting an impulsive rush of a charge, has 79 times higher insulation than air.

To obtain these results, we used a large and most powerful Wimshurst machine; but this evening, for convenience sake, we shall use a smaller machine. We may not be able to obtain quite as high comparative values, still we hope to obtain results showing oil to be 50 times better an insulator than air.

With the largest machine we obtained the following remarkable effects. The apparatus for holding the oil was a glass vase, 4 inches in diameter by 3 inches deep. The lower portion of this vase had a copper plate connected with one portion of the circuit. A brass knob, $\frac{1}{2}$-inch diameter, connected with the other portion of the circuit, could be raised or lowered in this vase in order to show the different striking distances when the vase contained air or oil. This gave the comparative results already mentioned; but, in addition, we noticed that when the knob was only three-quarters covered with oil, the spark rose from the upper portion to the upper portion of the vase, and then descended on the outside in order to reach the lower copper plate—a course of some 5 inches through the air, compared with $\frac{1}{10}$th-inch through oil. If now the current was increased, the current, or spark, became a continuous sheet flow all over the entire surface of the vase, resembling in appearance a waterfall, or exactly imitating the well-known Gassiot cascade. On again increasing the charge, in an attempt to pierce the oil, the spark pierced the glass vase, making a small hole of about $\frac{1}{10}$nd-inch diameter, at a place $\frac{1}{2}$ inch above the surface of the oil; thus the spark preferred to pierce the glass and travel several inches through air, rather than traverse a distance of $\frac{1}{10}$th-inch through oil.

I will now show several forms of oil insulation as applicable for submarine or subterraneous wires, and the remarkable power of self-restoration when the insulation is temporarily destroyed by a puncture or cut across, so as to lay the wire bare for an instant.

It will be seen in the experiments following this paper, that I have arranged a battery so that one pole is connected through a sensitive galvanometer to a metal tank containing salt water, the return circuit being completed through the salt water and wire to be tested to the other pole.

If we take any sample of gutta-percha-covered wire, and place it in the water, the insulation seems perfect and all that could be desired; but if we make a small incision with a knife, so as to leave a minute portion of the copper exposed, then (as we already know), on placing this in the tank, the water at once percolates through the cut to the wire, and its insulation is completely and permanently destroyed.

If we try this same experiment with oil cable, such as a bare copper wire in a gutta-percha tube containing oil, or, better still as a proof, a thinly coated gutta-percha wire, and this plunged into a small lead tube containing thick rosin oil, the whole having the same diameter as the gutta-percha-covered wires, we find, on testing this lead-covered oil cable, that its insulation is as perfect as the gutta-percha wires.

If we now cut through the lead tube and the gutta-percha wire once or several times so as to lay the wire bare, the insulation for an instant is destroyed, but in less than a second the oil percolates through the wound or cut, and its insulation is instantly restored to its previous high value.

I believe that these experiments sufficiently show the merits of a self-restoring insulating medium, such as rosin oil, for all purposes where a permanent insulation of wires conveying an electric current is desirable.

In conclusion, I will mention a few proofs of my claim to be the first to recognise the value of oil insulation for wires conveying an electric current, based upon some earlier experiments, but patented January 11th, 1859, entitled, "An Improved Mode of Insulating Electrical Conducting Wires," which describes and claims most of that which I have already related. I will read a few sentences, in order to prove this fact.

After showing how the oil may be applied to submarine cables, and in order to claim its application to underground wires, the specification says (page 3, line 10): "With some trifling modifications, the invention may be also applied for insulating electrical conducting wires employed on land or underground."

As regards the materials used, it says (page 4, line 23): "I propose and prefer to use rosin oil rendered sufficiently thick or viscid for the purpose by the addition of rosin or the solid residuum obtained from the distillation of palm oil."

In order to show that the interior wire may be covered with a fibrous material instead of gutta-percha, it says (page 4, line 34): "Instead of bringing the soft or semi-fluid restorative medium in direct contact with the enclosed wires, I sometimes first coat the wires with a non-conducting material, such as gutta-percha or india-rubber, and if preferred, the wire may be previously covered with some fibrous material."

My invention being as well adapted for numerous wires in an underground cable as in a single-wire cable, it says (page 5, line 6): "And the invention is as applicable when two or more electrical conductors are placed in one common tube or outer covering as when only one conductor is employed."

If the patent is hurriedly read, it would seem as if I only intended to use the oil in connection with gutta-percha cables; but I foresaw the use of other outer covering, such as lead or iron tubes, for it says (page 4 line 37): "The insulated electrical conductor thus coated or covered is then placed in a gutta-percha or other tube." This phrase "other tube" referred to my experiments with an outer tube of lead or other metal; and I again employ the same phrase at page 5, line 13, where it says that the wires surrounded by the rosin oil "may be placed in the gutta-percha or other outer covering."

A paper on this subject was read before the Society of Arts and published in their journal April 15th, 1859, in which I demonstrated by practical experiments the restorative powers of my fluid insulation.

Sir William Fothergill Cooke, the chairman, in reply, spoke in

praise of the results, and said he "also thought the invention would be very valuable as applied to the street wires of electric telegraphs, and these afforded more facilities for testing its value." So it cannot be said that its applicability to underground wires was not foreseen at that date.

From 1858 to 1860 I tried by every means to get the various land and submarine electric telegraph companies to try this system, but in vain. I thus lost two years of valuable time, and then went to France in connection with my printing telegraph instrument, to which I devoted my whole time for many succeeding years, thus practically abandoning my self-restoring fluid insulation to the public.

The cause of its failure to be used then was due to the fact that the invention was made before its time, or that the need of its use was not then as great as at the present time. I am glad to say that now, thanks to electric light and power, the use of a self-restoring oil insulation is fast coming into actual practice under the names and patents of numerous succeeding inventors; so I sincerely thank Mr. Preece for citing my early work, and thus giving me this opportunity of claiming as priority the work that I had done before and patented in 1859.

My best thanks are due to Mr. Preece for the samples of gutta-percha wires, galvanometer, &c.; to Mr. James Wimshurst for the loan of his static electric machine, and for its great assistance in preparing some of our experiments on high-tension currents; also to Grindley & Co., of Upper North Street, Poplar, for having supplied me with numerous samples of their best oil, from which I have selected the oil that I have used this evening.

"THE TELEPHONE AND THE POST OFFICE."

THE *New Review* contains an article by the Duke of Marlborough on "The Telephone and the Post Office." Against the Post Office the Duke makes a very sweeping charge. He says: "The Government, through the public department of this country, have stealthily and persistently endeavoured to blind the public to the possibilities of this marvellous invention." The reasons suggested for all this stealthy and persistent action are, that the Government purchased the telegraphs at an exorbitant price, have since spent enormous sums in the establishment of further communications and the purchase of elaborate telegraphic instruments, and consequently feared that the expenditure might be wasted if the telephone came into popular use. "When you can play a game of chess between Birmingham and London by telephone; when you can hear the Paris opera in your own sitting room in London; when you can telephone Lord Salisbury's or Mr. Gladstone's speech, as it is being delivered from the hall itself into the very office of the printing establishment of the Central News. . . . . it is not wonderful that the Post Office should view with alarm an invention of this order." Of course, the Duke of Marlborough did not intend these instances to be taken literally. They are no doubt adduced merely as picturesque illustrations of what the telephone can do. Taken literally, they go to show exactly the contrary to that which the Duke of Marlborough contends. The playing of games of chess between distant towns by telephone is an interesting feat, but it might be developed to a considerable extent without injuring any telegraphic revenue; the transmission of political speeches for press publication is well known to be more easily and cheaply effected by telegraph than by telephone: whilst the possibility of hearing the Paris Opera in London is nearer now than ever it was, and this is directly due to the British Post Office, by whom the English line and the Channel cable were planned and constructed. Under such circumstances, it is remarkable that it should be maintained that the Post Office has endeavoured, either stealthily or persistently, to blind the public to the possibilities of the telephone. The Duke of Marlborough might have found some form of expression which would have more justly represented a very general view—that the Post Office has stood in the way of telephonic progress. We cannot but think that too much attention is paid to the complaints of interested parties who on telephone matters assail the Post Office. The position is intelligible. The Post Office established its right to the telephonic monopoly, and it rightly protected the public interest thereby. It exacts a tribute from its licensees which they and their subscribers would doubtless prefer to be reduced. It is fair matter for consideration whether it might not reasonably be reduced, but at least it should be remembered that, in licensing its licensees, not only does the Post Office obtain an income, but its licensees make a very good living too. Assuming that there is any loss to the telegraphic revenue (which we do not take for granted) by the use of the telephone, it should be so amply made up by the receipts from telephonic licenses, that the Post Office ought not to have any motive to "blind the public," even if it desired to do so.

NOTES.

Mr. O. May's Universal Pincers.—Simple and practical tools are always welcomed by electricians, so we will call their attention to the universal pincers devised by Mr. O. May, of Frankfort-on-the-Main. This tool comprises a cutting portion, which enables us to cut wires up to five millimetres in diameter, a punch, a cutting plate, with which it is very easy to cut insulators or the lead in which cables are enclosed, scrapers for scraping the wires, blunt pincers at the extremity, and flat pincers.

A Proposed High Speed Railway.—We understand that it is proposed to construct at once an electric railway between St. Louis and Chicago, to cover the distance of 250 miles at the rate of something like 100 miles an hour. Our contemporary, the New York *Electrical World*, very wisely states that to operate 250 miles of track from a single power station is not a task likely to be undertaken, and unless an alternating motor more effective than any which have yet appeared should be among the improvements of the near future, the scheme is not even plausible. Our contemporary thinks that this plan is "worthy the impecunious representative of an alleged English syndicate."

Punkah Pulling by Electricity.—That electricity is a great economiser of manual labour will be admitted, we presume, by every-one, even by the gas companies. In hot climates anything that saves labour of this kind is obviously a great boon, and we have no doubt that the new electric punkah described in a recent issue of *Indian Engineering* will prove a peculiarly grateful luxury in the torrid climate of the East Indies. This novelty is due to F. J. Agabeg, and presents the following essential features:—The punkah is pivoted longitudinally over the bed (if it be used in the sleeping apartments), and vibrates in an arc from 150° to 160°. By means of an ingenious link motion, the fan gets a slow and quick movement alternately, which exactly imitates the jerk and swing-back of the ordinary punkah as manipulated by coolies. The electric power is furnished by batteries, the cost of which for from 18 to 20 hours is said to be about the same as that which would hire two coolies for the purpose. The electric punkah may be arranged to fan the air over dining tables as well as beds, and the comfort of dispensing with the attendance of the coolies while the fanning proceeds uninterruptedly, will doubtless bring the invention into popularity in India. It is stated that the battery cells which work the punkah are also capable of lighting up a three to four candle-power electric light at the head of the bed so that if desired, the occupant may read with perfect comfort and safety. There are no details at hand respecting the battery, unfortunately.

The Fate of a "Yaller" Dog.—Once there was a man who had a "yaller" dog. The dog himself felt very big, but he was really no bigger than common dogs, if as big, but that made no difference; he was great at barking, and when there was nothing near his size to bark at he would squat on his haunches and bark at the moon by the hour. But the moon kept right along just as if there never was a "yaller" dog. This made the "yaller" dog very mad and he tried to jump to the moon, but he fell short and the moon kept right along just the same. At last, the "yaller" dog died from sheer barking and jumping and the man who owned him has never had a yaller dog since. The moral of this Yankee story is in its application; whenever you see a paper whose chief business is "barking" at bigger papers "that keep right along," just think what became of the "yaller dog" that made barking at the moon his chief work. The dog died, and no one was sorry, but "the moon kept right along just the same."

Elmore Copper.—The *Engineering and Mining Journal* of the 27th ult. refers at some length to the Elmore Copper Depositing Companies, and particularly in connection with the bringing out of the American and Canadian Elmore Company. Our contemporary sums up the whole matter by saying that "the practical value of the Elmore patents should have been, and no doubt was, determined three years ago. Certainly nothing has been shown to justify the issue of $5,000,000 or any other amount of capital. The two parent companies have paid dividends out of the proceeds derived from the sale of the patents to the subsidiary concerns, but ultimately some one will have to earn profits in legitimate manufacture, and it has not yet been demonstrated that this can be done. On the whole, there has thus far been no evidence submitted to the public that changes our opinion that this concern seems to be exploiting the stock market and not manufacturing serviceable tubes, and that it is an excellent thing for American investors to let alone." How the American company will get on after this remains to be seen, but the experimental plant in New York will probably be the last, even if it is actually put up.

The Action of Heat on Permanent Magnets.—According to the researches of Stronhal and Barus permanent magnets which are exposed to the temperature of boiling water, lose from 28 to 67 per cent. of their magnetism. But, if after such treatment these magnets are magnetised anew, they lose on being again subjected to the temperature of boiling water, only a very small percentage of their magnetism. It appears also that a magnet which has been subjected to this demagnetisation and remagnetisation is less susceptible of deterioration under the influence of mechanical shock. Indeed one magnet after suffering repeated shocks only lost a small fraction of its magnetism. The results of these experiments suggest the possibility of obtaining powerful magnets of great constancy and durability by a simple and economical process.

The Electric Light in Madrid.—We learn from *Industries* that the electric light is coming more and more into favour in Madrid, and that most of the larger houses in that city are being fitted with it. The daily receipts of the central station of the Sociedad Madrilena alone are now over £120, the present price charged being 1s. per unit. The company, however, offer to reduce the price to 9½d. per unit when their daily receipts amount to £160.

The Telephone Question.—It is understood that the action of Sir Albert Rollit in giving notice of motion of rejection of the New Company Telephone Bill is the result of a determination to obtain, if possible, an enquiry of a wider scope than would ensue at the hands of an ordinary select committee. The aim is to place telephone companies on the same footing as gas and water companies, who are only authorised by Parliament to issue further capital on condition of offering the fresh issue to a competition by public auction, whilst the prices that may be charged are regulated by a sliding scale which provides that an increase of dividend shall entail a corresponding reduction of price to the consumer.

Artificial Globular Lightning.—The phenomenon of globular lightning has often been produced, notably by the late Gustave Planté who employed secondary batteries to show it on a small scale. Von Lepel has shown that this phenomenon can also be obtained by means of static electricity. When two small copper wires are led from a strong induction machine, and their terminals placed at a certain distance from the opposite faces of a plate of mica, ebonite or glass, "small luminous red balls will be seen, moving here and there, at times slowly, at others rapidly, and sometimes in a stationary position. The most remarkable effects have been obtained by von Lepel; when a disc of glass or paper rubbed with paraffine is used a slight current of air will readily remove the "balls," which disappear with a faint whistling noise. The phenomena are apparently associated with weak tension for when the tension is increased it disappears, and instead there is the ordinary spark discharge. Von Lepel is inclined to believe that small particles of liquid or of dust form the vehicles of this luminous phenomenon, but he is not very clear in the arguments which he uses in support of this view.

Killed by an Electric Shock.—Mr. W. J. Harris, the coroner for Kent, was engaged for five hours at Chatham on Monday, in investigating the circumstances attending the death of Albert George Jay, to which we refer in our leading columns. Dr. Walter Buchanan stated that he had made a post-mortem examination of the body, assisted by three other medical men. All the principal organs were in a deeply-congested condition, and the blood had turned black, and the appearances were entirely consistent with death from an electric shock. Mr. Albert Maund, electrical engineer, stated that he examined the wires and transformer immediately after the accident, and found that there was no insulation on one of the wires, except a slight covering of India-rubber. One of the primary fuses was melted, and, judging by the discolouration of the wall, there had evidently been some "sparking." In reply to Major Cardew, Board of Trade electrical adviser, the witness stated that Readwin undoubtedly got a shock through the dampness on the wires, and by stepping from the board on which he had been standing on to the damp floor, he established a current powerful enough to give him a shock. He subsequently discovered that the reason why the electric light could not be used in this shop was because the service line at the top of the house was broken from the overhead main, and not because of any internal defect in the apparatus in the cellar. The following was the verdict: "The jury are unanimously of opinion that the deceased came to his death through an electric shock by misadventure: and, in their opinion, greater care should be observed by the electric lighting company in providing switches to turn off the current from the various circuits of wires as occasion requires, and that they should strictly prohibit workmen from executing repairs whilst the current is on." It transpired that Readwin is lying in the local hospital in a precarious condition, and it is feared that it will be necessary to amputate his hand and foot.

Statistics of Terrestrial Magnetism.—The following observations were made on January 1st by Mons. Moureaux, and are abstracted from a paper read at the meeting of the Paris Academy of Sciences on January 4th. The figures represent absolute values. For the observatory at Parc Saint-Maur (48° 48′ 34″ N., and 0° 9′ 23″ W.).

Declination...	15° 15′·7
Inclination	65° 9′·4
Horizontal component	0·19580
Vertical "	0·42278
Total force	0·46592

For the observatory at Perpignan (42° 42′ 8″ N., and 0° 32′ 45″ E.).

Declination	14° 18′·8
Inclination	60° 15′·1
Horizontal component	0·22248
Vertical "	0·38930
Total force...	0·44839

The Incandescent Lamp Monopoly.—The Sunbeam Lamp Company, Limited, Gateshead-upon-Tyne, is circulating the following letter among its clients:—"Dear Sirs,—We much regret to have to inform you that owing to action taken by the Edison and Swan Company, we shall be unable, during the continuance of the Edison patent, to meet any more of your valued orders for 'Sunbeam lamps.' We have consented, rather than enter into a costly litigation with the Edison and Swan Company, and in view of the early expiry of both their patents, to suspend their manufacture." The high-handed treatment accorded to the electrical trade by these lamp monopolists will not be forgotten, says *Electrical Plant*, when their patents expire. With their huge capital, they have succeeded in crushing out of existence all rivals; but their triumph will be a short-lived one now. At the present time lamps up to 25 C.P., with a guaranteed life of from 800 to 1,000 lamp-hours, may be obtained in Germany for 1s. 9d., whereas in England, for the same article, we have to pay 3s. 9d., or more than twice as much; and our contemporary does not hesitate to assert that the outrageous price extorted from the trade for the lamps has been one of the principal hindrances to the development of domestic electric lighting.

Train Lighting in Germany.—The first and second class carriages of some of the trains running between Meiningen and Lichtenfels, on the Werra Railway, have recently been lit up with the electric light. Each carriage is provided with one lamp of 12 C.P. and four lamps of 8 C.P. Should the experiment prove successful, the electric lighting of the trains of the company is to be extended.

Amalgamation of Electric Companies.—Referring to our recent note on the subject of the amalgamation of the businesses of the Thomson-Houston and Edison Companies in America, we notice that our New York contemporary, the *Electrical Engineer*, gives further particulars regarding the matter. The formal assent by the holders of a majority of the stock of both companies is not to be finally decided until May 1st, but we understand that the consolidation is a foregone conclusion. It seems quite reasonable, says our contemporary, to expect that the absorption of the Westinghouse Company into the proposed new corporation will soon follow. The provision of $16,600,000 of stock—$6,000,000 of which is in preferred shares—remaining to the treasury after taking up the Edison and Thomson-Houston stocks, is thought by many to imply the use of a considerable portion of it in taking over the Westinghouse Company when convenient; but no definite information of such a plan has been made public. The name of the new company has not yet been officially announced, but it is understood that "The General Electric Company of America" has been considered a proper title. Numerous changes will, of course, take place in the management and staff generally. In another article, also referring to this combination, our contemporary refers to the respective positions and reputations of the two companies, and states that the Thomson-Houston Company comes out a little ahead in many ways. The repeated changes in organisation and management of the Edison Company have doubtless contributed to a large extent in bringing about this result, but our contemporary suggests that a more important cause is evident in the attitude taken up by Mr. Edison in relation to alternating current distribution, which system he did not consider meritable. It has, however, been very clearly seen that since its introduction for long-distance service, six years ago, it has practically driven the direct system from the field of much central station business.

Long Distance Transmission of Power.—In our American contemporary of the same name, has recently appeared a brief abstract of a paper on long distance power transmissions by electricity, by Mr. Francis Hart. Though not containing matter of much originality it gives a very good summary of the various possible methods of transmitting power electrically, and a digest as to their relative merits and demerits. It also contains one of those diagrams for quickly performing simple calculations of which the American technical papers have published a good many recently. In this case its use is to give a rapid approximate estimate of the weight and section of copper required to transmit power with various percentage losses at various voltages.

Water Purification by Electricity.—We learn that the method of purifying waste water known as the "Webster" process, and which involves the use of electricity, has been recently placed under a searching investigation by Dr. Fenni in the Hygienic Institute of Munich. Impure water, containing a considerable quantity of organic matter was clarified in less than half an hour, the impurities being reduced 50 per cent. and all suspended matters being thrown down as a precipitate. Dr. Fenni's report was, on the whole, distinctly favourable. The process could not be considered to be an ideal one, since the organic impurities were only reduced in quantity, not completely eliminated. But although the Webster process in its present condition does not exactly realise the ideal of water purification, it presents two distinct advantages which are worth noting. The first of these is that the removal of iron salts in solution is not so difficult as by methods which are more strictly chemical in their action, and in the second place the dissolved organic substances which are not precipitated by any, we believe, of the chemical methods which are at present in operation, are, at least, partially removed by the action of the electricity as applied in the Webster process.

A New Insulator.—An account has been received of the production and exportation of chicle in the States of Campeche and Yucatan, Mexico. Chicle, the sap of the sapotille tree, is extracted like camphor, India-rubber, and other gum, and the entire output, amounting to something like 50,000 lbs. last year, is exported to the United States, where it enters into the manufacture of chewing gum. The market value of chicle is 1s. 3d. per lb. Chicle is an insoluble substance, and it is said to be now used extensively as an insulator, replacing India-rubber.

Crystal Palace Exhibitors.—What seems a somewhat peculiar request has been made by the Crystal Palace Company's engineers, in asking exhibitors to cover up the lenses of projectors on show, lest the sun shining through them should set fire to the woodwork and fixtures in close proximity to these instruments. It appears to us that it is quite unnecessary to demand these precautions to be taken until some alteration has been effected in the appearance of the glass work of the buildings; as at present, the rather dirty condition of the glass renders it impossible for the rays of the sun to penetrate through it in a very powerful degree. Supposing, however, that the sun were to come through with the full light and heat of midsummer, even then there could not be any very disastrous results, seeing that the lenses are "dispersing," and therefore quite unable to focus the sun to a burning point, even if the sun's rays managed to get in the right position. We further fail to perceive how any harm can be done to the woodwork round about; possibly it might start the search light by heating the carbons!

St. Pancras Vestry Electric Lighting Bill.—As we stated in a note last week, the St. Pancras Vestry have given notice of the withdrawal of their deposited Bill. A letter in explanation of this appeared in the *Times* from Mr. Andrew Sweet, the Chairman of the Electricity Committee, St. Pancras. From his remarks, it seems that the general impression prevailing is that having withdrawn their Parliamentary Bill, they are tired of electric lighting, and have no intention of extending it in the parish. Mr. Sweet, however, states that this is entirely a mistake:—"The first object of promoting the Bill was to raise money from the public when a difficulty arose between the Vestry and the London County Council as to the period over which the repayment should extend. Since then the difficulty has been surmounted and the necessary money has been borrowed. The present necessity for the Bill, therefore, has gone." He further adds that electric lighting in St. Pancras is an assured success, and the Electricity Committee are now taking the necessary steps to extend the public lighting, which was commenced in Tottenham Court Road and Euston Road, through Hampstead Road and Camden Town. Furthermore, every day during the last fortnight they have at least one new applicant for current, and on 3rd inst. there was an application from one consumer for about 600 lights.

The Price of Patent Specifications.—An important change has been made in the price of patent specifications. It has been found, says the *Engineer*, that at the price of 8d. each, without variation on account of size, and without any extra charge for postage, these publications might be sold without affecting the receipts of the Patent Office, whilst much correspondence and delay would be saved to patent agents and others concerned. Henceforth any specification in stock can be obtained from the Patent Office at this price, and arrangements have been made with the Postmaster-General by which postal requests in the form of a postcard, price 8d., will be on sale at each Post Office, so that anyone knowing the number and year of a particular patent may, on filling in the blanks on the card, have a copy of the specification delivered at his address by return of post, without further expense or correspondence. The change came into operation on March 1st.

Electric Power Plant in Spain.—La Sociedad Molmo Harmero y Luz Electrica at Tolosa in Spain is erecting a generating station in close proximity to water power, which will be used in the generation of the current. The current will be used both for driving the machinery in and lighting two flour mills respectively distant from the generating station 3,936 feet and 4,428 feet.

An Electro-Therapeutic Exhibition.—A medical congress is to be held at Milan in May next, when an exhibition of electro-therapeutical instruments will be held.

Another Proposed Amalgamation in America.—It has been repeatedly suggested, says the New York *Electrical World*, by members of the National Electric Light Association and the Association of Edison Illuminating Companies, that there were many reasons why the two associations should be united into a single organisation, but a union of the two has never been officially considered. The consolidation of the Edison and Thomson-Houston Companies would seem to have removed the last objection to the formation of a united association. Our contemporary gives the opinions of H. Ward Leonard and other American authorities on the subject.

Beckenham Local Board and Electric Lighting.—On Monday, at a meeting of the Beckenham Local Board, a letter was read from the Crystal Palace and District Electric Light Supply Company, Limited, asking the board to consent to the construction of an underground apparatus in Sydenham Terrace. Mr. C. E. Baker said the company proposed to store electricity of 2,000 volts strength, which would, before being used, be reduced to 200 volts. He thought the board should have the advice of a special electrical engineer before sanctioning such a station. The application was referred to a committee.

The Electric Light in Italy.—The town of Grosseto in Italy is to be lighted by electricity. The contract has been secured by Messrs. Siemens and Halske of Berlin.

Private Lighting.—Dulgellyoneth, the country seat of a North Wales nobleman, will, it is stated, be illuminated throughout with electricity next month. Altogether there will be over 220 lamps used.

Government and the Telephone.—At last Wednesday's meeting of the Chambers of Commerce, it was resolved: "That in the opinion of this association it is desirable, for the due development of the telephone system of the country, that the Government be asked to take it over; provided, however, that satisfactory assurances can be obtained that the Government officials are prepared to work the system, and extend it, with vigour and efficiency." A resolution was also passed dealing with the subject of protecting telegraph wires by laying them underground or in some other effective manner. There was a long discussion on the matter of coast communications, and a resolution was eventually passed urging upon the Government the necessity for appointing a committee to rigorously consider the subject.

The London Electric Supply Corporation, Limited.—A "country shareholder" writes to us, just as we are going to press, to the following effect:—"Permit me to avail myself of the columns of your excellent paper to invite the attention of my fellow-shareholders in this Company to the miserable condition into which it has apparently fallen, and to urge upon them the necessity of attending in force the fifth annual meeting (due this month), and demanding from the directors a full explanation of their policy and some promise of reform. So far as I can learn, the Corporation are doing little or no business to speak of, whilst its shares in the market are quoted at "rubbish" prices. Would it not be well also if some new blood of a more practical quality was infused into the board, and if the gigantic apparatus at Deptford, with its unmanageable high tension current, is really a failure, to get rid of it and adopt the humbler but surer system worked by the successful companies alongside of us."

Telephone Bills in Parliament.—The time has expired, says the *Financial Times*, for depositing petitions in the House of Commons praying to be heard by counsel in opposition to the National Telephone Company's Bill, and the Bill of the New Telephone Company. There are 112 separate opponents to the National Telephone Company's Bill. As regards the Bill of the New Telephone Company, the total number of separate petitions actually deposited in opposition is 63, but of this number two petitions represent 13 Corporations and 16 Local Boards respectively.

Fire.—A fire broke out last Sunday afternoon in the workshop of the General Electric Company, Clegg's Court, Chapel Street, Salford. It was found that the fire had its origin in a wooden shed used as a boiler house. The Salford fire brigade succeeded in confining the fire to the shed. We understand that the damage was slight, and will not affect the output of the works.

University College, Liverpool.—Prof. Oliver Lodge intends shortly to fit up and furnish an iron building as an electro-technical laboratory for students in electrical engineering at University College, Liverpool. The committee of the County Council of Liverpool have made a grant for the purpose; and the staff proposed is a highly qualified demonstrator or assistant lecturer, a mechanic, and a boy. It will no doubt develop into a larger and more pretentious building as time goes on. For their mechanical engineering the students will be under Prof. Hele Shaw in the splendidly equipped Walker laboratories. Prof. Lodge hopes to have everything ready for work on October 1st.

Personal.—We understand that Dr. Louis Bell, who for the past two years has occupied the editorial chair of the New York *Electrical World*, retired on March 1st from it with a view of taking a more direct part in the engineering work that is now entering a period of such tremendous activity. In view of his resignation, Mr. Carl Hering, who has been connected with the *Electrical World* for some time as technical writer, will be in charge of the technical department of the paper.

Electric Lighting of Llanelly.—At the monthly meeting of the Llanelly Local Board, held last Monday, the question of lighting the town by electricity came up for discussion. An important item on the agenda was that of opening the electric lighting tenders; but as only two were received, one from the Llanelly Electric Lighting and Power Company, and the other from Messrs. J. D. F. Andrews and Co., London, it was decided to go into committee over them. This was done, and eventually a resolution was adopted to the effect that the matter should be referred to a special lighting committee of the whole board.

Edinburgh and Electric Lighting.—At a meeting of the Edinburgh Town Council, held on Tuesday last, Mr. Macnaughten asked what the Sub-Committee of the Town Council, appointed to consider the question of electric lighting, was doing. In reply, it was stated that the Sub-Committee were collecting information from towns in England and Scotland as to whether it was advisable to take up the work themselves or hand it over to a company.

Electric Tramcar Experiment at Bradford.—On Monday last the work of constructing a short line of electric wires from Forster Square, up Cheapside, to Manor Row, Mannington Lane, was completed for the purpose of making an experiment with electricity as a motive force. This work is being carried out according to the scheme of Mr. Holroyd Smith, of Halifax, a portion of the expense being defrayed by the corporation, who will supply the electricity for the works in Canal Road.

The Electric Light in the City.—At last Tuesday's meeting of the City Commissioners of Sewers, the solicitor submitted his report, which showed that the dates for the completion of the contracts for the electric lighting of the eastern and western districts had expired. The Clerk read a letter from the electric lighting company, stating that they expected the work in the eastern and central districts to be completed within three weeks, but the contract for the western district would not expire until November 5th next. Mr. Harris asked leave to move a resolution to the effect that the whole question should be considered by a committee of the whole court, and that they enquire into the non-completion of the contracts. This, however, was very strongly opposed, and the resolution was not allowed.

Telephones in the United States.—8,256 tons of copper wire, having a total length of 98,000 miles, will be used in the 50 long distance telephone lines at present in course of erection between New York and Chicago, by the American Bell Telephone Company.

North East Coast Institution of Engineers and Shipbuilders.—At the fifth general meeting of the session of this Institution, to be held at Newcastle on March 17th, a paper is to be read by Mr. J. Brentnall Duckitt, on the "Distribution of Electricity for Lighting Purposes."

Cape Town Telegraph Tariffs.—According to the *Financial News* the Cape Town Chamber of Commerce is advocating a reduction by one-half of the present cable tariff.

Isle of Man International Exhibition.—The extensive works now being carried on at the site of the exhibition at Douglas, are beyond anything the island has attempted before. The appearance of the extensive grounds is being entirely changed. The river is being deepened, and the racecourse raised, and roomy buildings are being erected to accommodate the large number of exhibits which will arrive from all parts, as applications have been received from many of the leading manufacturers of England and Scotland.

Fulham and Electric Lighting.—We hear that the Putney and Hammersmith Electric Power Supply, Limited, have abandoned their intention of obtaining powers for supplying electricity to the parish of Fulham, under the West London Electric Lighting Order.

Honour to whom Honour is Due.—Prof. Hughes has, we imagine, surprised the electrical profession generally by the contents of his remarkable paper on "Oil as an Insulator," and has added fresh laurels to his fame as an original investigator. It is the fashion, now-a-days to re-invent the discoveries of a by-gone age, and doubtless the position of Prof. Hughes with regard to oil insulation is identical with that of many old time experimenters in other branches of scientific investigations, if only the truth were known.

Petroleum Engines.—The ordinary meeting of the Institution of Civil Engineers on Tuesday was occupied by the reading, and in part discussion, of a paper on "Petroleum Engines," by Prof. W. C. Unwin, F.R.S., M.Inst.C.E. In a petroleum engine, in which the fuel was introduced into the cylinder without the loss involved in working a gas-producer, the thermo-dynamic efficiency might be expected to be more than double that of a steam engine and boiler. The author gave a short account of the earlier petroleum engines, and then described the Priestman engine. To compare the fuel consumption with that of a steam engine, 1 lb. of oil might be taken as equivalent to 1¼ lb. of coal. Then the consumption in the oil engine was equivalent in several trials to 1·18, 1·23, and 1·02 lb. of coal per brake H.P. per hour. The author believed that this was a remarkable thermo-dynamic result, and generally speaking his experiments more than corroborate all that we have ever said in favour of the Priestman engine.

National Electric Light Association.—The following papers were read before the National Electric Light Association at its fifteenth convention held at Buffalo, N.Y., on February 23rd, 24th and 25th:—"Transmission of power" by Carl Hering; "The Allied Powers" by D. Ashworth; "The Alternating Current Motor" by William Stanley; "Electric Lighting from a Financial Standpoint" by Erastus Wiman; "Switchboards: Their Safety and Operation" by M. C. Sullivan; "From the Tannery to the Dynamo" by Chas. A. Schieren; "Municipal Franchises for Quaisi-Public Corporations" by Allen R. Foote; Overhead Construction" by E. F. Peck; "Operations of High Tension Currents Underground" by E. A. Leslie; "Underground Construction of Buffalo Railway Company" by J. R. Craven.

Exhibition Lighting in Vienna.—An international musical and theatrical exhibition is to be held in Vienna during the present year. The exhibition will be illuminated by electricity, the contract for the work having been given to the Allgemeine Electricitäts Gesellschaft, of Berlin, and Messrs. Grob and Company, of Leipzic.

The Electric Light in Germany.—A central station is to be erected in Tuttlingen in Wurtemburg, for the electric lighting of the town. Water power is to be employed in the generation of the current.

The Phonopore in Switzerland.—Some trials with the phonopore, were recently carried out under the direction of M. Rod, inspector of telegraphs on the Jura-Simplon Railway, between Lausanne and Montreux, on a line about 22 miles long. The result of the trials was very satisfactory, the regulation of the apparatus presenting no difficulty, and it is said that the Jura-Simplon Company are disposed to adopt the phonopore on their railway.

Military Telegraphs in the United States.—A Bill has been introduced into the United States Senate to provide for the construction of military and commercial telegraph lines along the Pacific Coast, between Yaquina City, on Yaquina Bay, and Port Oxford, to connect Newport, on Yaquina Bay, and Alsea Bay; Florence, on Suislaw Bay, Gardiner, on the Umpgua River, Empire City and Marshfield, on Coos Bay.

Subaqueous Cables in Switzerland.—The new subaqueous cable across Lake Constance, between Romanshorn and Friedrichshafen, joining the Wurtemburg and Swiss system of telegraphs—to replace the one broken last year—is said to be somewhat longer than the old cable, but when it was being laid owing to some mistake, it was found to fall short at a distance of 1¼ miles from the shore. Operations have therefore had to be suspended, in the meanwhile the end of the cable is attached to a buoy. Something strange about this!

Electric Light in the Leeds Municipal Buildings.—At last week's meeting of the Leeds County Council, it was resolved that the council authorise the Corporate Property Committee to provide a new installation of electric lighting for the free public library in the municipal buildings, at an estimated cost of £500.

Electric Lighting at Brighton.—The following tenders have been received for the supply of cables necessary for laying certain distributing mains ordered by the council. For mains with resistance of 1,000 megohms per mile. Siemens Bros. & Co., £2,230; Callender and Company, £2,278; W. T. Glover and Company, £3,085. The lighting committee resolved that the tender of Messrs. Siemens Bros. & Co. to supply the cable required with a resistance of 1,000 megohms per statute mile, for the sum of £2,230 be accepted.

Leeds Association of Electrical Engineers.—At the ordinary monthly meeting of this association, a paper was read by Mr. J. Hartley Wicksteed on "Friction of lubricated bearings founded on the researches of the Institution of Mechanical Engineers."

Exeter Electric Lighting Company.—Mr. H. G. Massingham, managing director of the Bath Electric Lighting Company, has by the request of the directors and shareholders of the Exeter Electric Lighting Company, assumed, as lessee, sole control over the work of that company. It was considered by the management that by this means the concern could be conducted more successfully, and results have fully justified this opinion, as the works are at this moment realising a profit to the shareholders.

World's Electrical Congress.—It has been arranged by Mr. C. C. Bowney, president of the World's Congress Auxiliary of the Columbian Exposition, Mr. O. Chanute, chairman of the Engineering Congress Committee, and Mr. Elisha Gray, chairman of the Electrical Congress Committee, that the section of the Engineering Congress relating to electrical engineering shall be merged into the World's Electrical Congress. Due notice of this agreement from the office of the World's Congress Auxiliary will follow the recently distributed circular relating to the Engineering Congress.

NEW COMPANIES REGISTERED.

Hobart Tramway Company, Limited. — Capital £105,000 in £1 shares. Objects: To construct, equip, maintain and work, by means of electricity, or in any other manner, any tramway, and particularly tramways, situate at Hobart, Tasmania; to carry on the business of an electric light company in all its branches, and particularly to form centres at which electric power may be generated and accumulated, and from which the same may be distributed for the

lighting of streets, public buildings, houses, &c. Signatories (with one share each): A. F. McLellan, 24, Bedford Road, Tottenham; R. D. Wilkinson, 2, Elmwood Road, North Park, Croydon; C. A. Miller, 6, Carlingford Road, N.W.; A. D. Foggo, 4, Osborne Road, Thornton Heath, S.E.; A. Stewart, Worcester House, Walbrook, E.C.; G. C. Harrower, College Hill Chambers, E.C.; W. R. Harrower, College Hill Chambers, E.C. The number of directors is not to be less than one nor more than seven, the first being Sir Edward N. C. Braddon, K.C.M.G.; C. Barclay, A. Mattei, LL.D.; J. C. Bellamy, J. W. Syme and C. H. Grant. Qualification £100 in shares. Remuneration £100 per annum each, and £50 additional for the chairman. Registered on the 4th inst. by Linklater, Hackwood, Addison and Broun, 2, Bond Court, Walbrook, E.C.

Boardman's Electric Sun Lamp Patents, Limited. Capital £10,000 in £5 shares. Objects: To carry on the business of an electric light, power, and manufacturing company, in all or any of its branches; and to apply for, purchase or otherwise acquire patent or patent rights connected with the use of electric light, power, or force. Signatories (with one share each): C. E. Baker, 22, Gt. George Street, S.W.; S. P. Freeman, 13, Queen Street, E.C.; H. H. Bothamley, 13, Queen Street, E.C.; C. Nelson, 15, Clapham Park Road, Clapham, S.W.; J. C. B. O'Reilly, 20, Landcroft Road, East Dulwich; H. S. Haselgrove, 320, Friery Road, Dulwich Rise; J. S. Narder, Lincoln's Cottage, Leytonstone. Registered without articles of association on the 5th inst. by C. E. Baker, 22, Gt. George Street, Westminster, S.W.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Andrews and Preece, Limited.—The first annual return of this company, made up to December 31st, 1891, was filed on the 22nd ult. The nominal capital is £25,000, divided into 300 deferred and 2,200 ordinary shares of £10 each. Of these, 300 deferred and 408 ordinary shares have been taken up, of which the deferred shares had been issued as fully paid. Upon the ordinary shares the full amount had been called, resulting in the payment of £4,015, and leaving £65 unpaid.

The second annual return of the same company, made up to the 11th ult., was also filed on the 22nd ult., no change having been made. Registered office, Borough Mills, Manchester Road, Bradford, Yorks.

British Insulated Wire Company, Limited.—The first annual return of this company, made up to 24th ult., was filed on the 5th inst. The nominal capital is £110,000, divided into 300 founders', 3,950 preference, 9,450 ordinary "A," and 8,300 ordinary "B" shares of £5 each. At the time of making up, 16,532 shares had been taken up, and upon 300 founders', 3,250 preference, 2,552 ordinary "A" and 7,018 ordinary "B" shares the full amount has been called, while upon 400 preference and 3,002 ordinary "A" shares £1 5s. per share has been called. The calls paid amount to £69,015, and unpaid to £837 10s. Registered office, Prescot, Lancashire.

Carbon Electric, Limited.—The registered offices of this company have been removed from 24, Moorgate Street, E.C., to 33, Old Broad Street, E.C.

Weymersch Electric Battery Syndicate Limited.—The first annual return of this company, made up to the 11th ult., was filed on the following day. The nominal capital is £20,000 in £5 shares, of which 3,807 have been taken up. 3,000 shares were issued as fully paid in full satisfaction of the purchase price. Upon 200 of the remainder the full amount has been called upon 600 £4 per share called, and upon the remaining 7 no calls have been made. The calls paid amount to £2,800. Registered office, 2, Victoria Mansions, Victoria Street, Westminster, London, S.W.

Electric Tram Car Syndicate, Limited.—The annual return of this company, made up to January 12th, 1892, was filed on the same day. The nominal capital is £20,000 in £10 shares, 1,814 of which have been taken up; of these, 1,300 have been issued as fully paid, while the full amount has been called on the remainder. The calls paid amount to £5,130, and unpaid to £10.

At special general meetings, held at 31, Lombard Street, E.C., on February 11th and 26th, 1892, resolutions for the raising of the capital to £25,000, by the creation of 500 new ordinary shares of £10 each, were respectively passed and confirmed. Registered office, 31, Lombard Street, E.C.

Cuba Submarine Company, Limited.—The annual return of this company, made up to the 24th ult., was filed on the 4th inst. The nominal capital is £220,000, divided into 16,000 ordinary and 6,000 preference shares of £10 each, all of which have been taken up, the full amount called, and all calls paid. Registered office, 58, Old Broad Street, London, E.C.

Durand Electric Petroleum and Gas Engine and Manufacturing Company, Limited.—In reply to inquiries from the Joint Stock Companies Registration Office, Somerset House, W.C., with reference to the non-filing of the annual returns according to statute, Mr. F. E. Wright, of 175, Strand, W.C., wrote on the 17th ult. to state that the above company had never allotted any shares, had never had any shares subscribed for, or traded in any way, and should have been removed from the Register. Registered office (although not acknowledged), 175, Strand, London, W.C.

Electric Tramways Construction and Maintenance Company, Limited.—The annual return of this company, made up to February 13th, 1891, was filed on the 8th ult. The nominal capital is £250,000, in £1 shares, of which seven have been taken up, and nothing paid thereon. Registered office, Royal Insurance Buildings, Crossley Street, Halifax, Yorks.

Simplex Electrical Syndicate, Limited.—The following notice was filed on the 17th ult.:—"To the Registrar of Joint Stock Companies,—I have to inform you that a meeting of the Simplex Electrical Syndicate, was duly held on February 16th, 1892, for the purpose of having an account laid before them, showing the manner in which the winding up of the company had been conducted and its property disposed of, and that the same was done accordingly. (Signature.) W. J. M. Menzies, liquidator." Registered office, 109, Farringdon Road, E.C.

Thorneburry Miners' Safety Lamp Co., Limited, (Electric and General Lamp Manufacturers). In reply to an inquiry from the Registrar of Joint Stock Companies, respecting the non-compliance of the company in filing their annual returns, the following letter has been filed: "85, Gracechurch Street, E.C., February 17th, 1892. To the Registrar of Joint Stock Companies, Somerset House, W.C. Dear Sir,—I am in receipt of your favour of the 16th inst., and in reply beg to state that the general meeting of the company will be held on Tuesday next, and the returns will be filed in due course. I am, your obedient servant, Robert J. Danter, Secretary."

BUSINESS NOTICES, &c.

The Planet Electrical Engineering Company, Limited.—This company, having completed the electric light installation at the Mansion House, an appropriate ceremonial inauguration took place on Monday evening last, when a presentation of a battery reading lamp was made, on behalf of the company, to the Lady Mayoress. The Lord Mayor, in returning thanks, expressed his satisfaction with the convenience and comfort of the new light, and with the way in which the contract had been carried out. The installation consists of 825 incandescent lamps, fitted over the whole of the Mansion House, including the Egyptian Hall, Venetian Room, Long Parlour, Saloon, State Drawing Room, Lady Mayoress Boudoir, Justice Room, Morning Room, &c. The work has been carried out to the specification of W. H. Preece, Esq., F.R.S., and the wire has been run in such a manner that not more than 10 lamps are placed upon one circuit, and economical burning has been fully worked out by arranging that the lamps on all the cluster fittings are split up into two or more circuits, so that a few lights for general use may be turned on instead of the whole of the lamps. Two main distributing boards have been placed in the basement, one to control the Egyptian Hall lights, and one for the rest of the lamps. Inside the Egyptian Hall two sub-distributing boards have been placed to control these lights, and outside the other principal rooms sub-distributing boards have been fixed to control the lights on their respective circuits. Mr. Slatter, the company's manager, seems to have made himself very popular with the Mansion House officials, and he was warmly congratulated by the Lord Mayor upon the success which the company had achieved. The current is supplied by the City of London Electric Lighting Company.

Austin's "Domestic" Motor.—Messrs. Austin and Myers, of Leeds, have designed a special motor for household purposes, with a view of obviating the mishaps which usually befall such machines in inexperienced hands. For instance, the importance of keeping the lubricators fully supplied with oil, and of properly adjusting the brushes, is often lost sight of. In this machine the spindle runs in roller bearings in such a way that should there from any cause be neglect in oiling, there is no liability to any damage from bearings getting too hot and grinding away. In fact, in cases where the machines are only worked intermittently, such as driving sewing machines, &c., they need not be oiled at all, or only at long intervals. They would give a better efficiency when working without oil, but the rollers would be liable to wear out sooner than when oiled occasionally. The brush holders feed the brushes automatically until they are entirely worn away. There is no screwing or unscrewing in order to replace a new brush, and no setting or adjusting when brushes have been put in. To replace the brushes it is only necessary to lift the feeder and place the brush in from behind. The feeder

is worked by a spring, and is so shaped that it gives an equal pressure in all positions. The brushes are in a line with the diameter of the commutator, so that the armature spindle can be turned in either direction. The armature and commutator connections are entirely covered in and protected from danger. As will be seen from the illustration, the machine is very compact, and takes up little space.

Electric Light at the Manchester Central Railway Station.—Referring to our note a few weeks back regarding the installation of the electric light at the Manchester Central Railway Station, we notice our contemporary, the *Manchester Guardian*, in commenting upon the results, states that the general arrangement of the lighting has been settled by Mr. W. G. Scott, the chief engineer of the Cheshire Lines Committee, and they have been so well pleased with the results, that they have commissioned Messrs. Mather and Platt to make the necessary increase in the plant for lighting the whole of the goods department. Active preparations are now being made for the erection of 76 1,000-candle-power and 10 2,000-candle-power arc lamps, and 65 16-candle-power incandescent lamps. It is expected that these will be at work in the course of the spring, and the whole of the gas will then be replaced by the electric light, the installation forming one of the most important which has yet been supplied to any railway company in the kingdom.

Ernest Scott & Mountain, Limited.—This firm has lately published a nicely illustrated and fully descriptive edition of its general engineering catalogue. This list principally particularises the various specialities, amongst which the following are included: Triple-expansion engines for mills and gunboats, launch engines of all types, Admiralty pattern feed, fire and bilge pumps, air and circulating pumps, workshop engines and condensers, also all classes of forced draught fans suitable for war ships, passenger and cargo steamers, hydraulic pumps, and illustrations of the larger class of gun-metal and brass castings which the foundry is capable of producing. Prices, and very full particulars of the machinery, &c., are given, and we believe that the catalogue will be of interest to all, more especially so as we think it is the first that has been issued of auxiliary machinery for warship and passenger and cargo steamers, by any firm.

The Electric Light in the City.—Great progress is being made with the adoption of the electric light in the City. Since our last report, we learn that the Consolidated Bank, in Threadneedle Street, is being fitted by Messrs. Woodhouse, of Queen Victoria Street. The offices of Lloyd's Register of Shipping, White Lion Court, Cornhill, is being fitted by Messrs. Laing, Wharton and Down, of New Bond Street. The premises of Mr. A. Monarch Kino, tailor, of 93, Gracechurch Street, are being fitted by Mr. J. H. Scott, of Bow Lane, Cheapside, while Messrs. Drake and Gorham, of Westminster, are putting in an installation in Brooks's Bank, Lombard Street.

Tenders Wanted.—Douglas.—Tenders are invited for maintaining an electric light installation at Falcon Cliff Grounds, Douglas, Isle of Man. Full particulars can be obtained from Mr. Rowe, Secretary, Cliff Company, Douglas.

The Electric Light in the St. Pancras District.—As was to be expected when the central station in this district was put into operation, a large number of installations in and about Tottenham Court Road are at present in course of completion. On a recent visit to the district we noticed that the premises of Mr. R. J. Dodd, chemist, 70, Tottenham Court Road, was being fitted by Messrs. Ewart and Son, of 346, Euston Road. The premises of Messrs. Gowlesland, outfitters, of 121, Tottenham Court Road, are being fitted by the Electric Power and Traction Company, Limited, of Kentish Town. This company are also fitting up an installation in the premises of Mr. Adolph Stangl, hairdresser, of 8, Hampstead Road. They are also fitting up an installation in the grocery stores of Mr. William Edwards, in the Hampstead Road, and also on the premises of Messrs. Elené et Cie, milliners, at 118, Tottenham Court Road. Mr. Henry Conolly, electrical engineer, of Hampstead Road, is fitting up an installation in the premises of Mr. Justin Brown, piano manufacturer, Euston Road. The premises of Messrs. Charles Baker and Sons, tailors, &c., at the corner of Euston Road and Tottenham Court Road, are being fitted up by Messrs. Sharp and Kent, of Westminster. Messrs. John Pound & Co., portmanteau makers, of Leadenhall Street, E.C., who recently established an electrical branch to their business, are fitting up an installation in their branch shop at 118, Tottenham Court Road.

Quick Work.—On Monday evening last week, orders were given to Roper's Electrical Engineering Company, Limited, of Bradford, to instal 250 incandescent lamps in the Vatican Bazaar, held in the Leeds Town Hall. Work was not begun till 11 o'clock on Tuesday, but the whole of the lamps were erected and burning by 12 o'clock the next day, the current being supplied from the corporation dynamos. Though done so expeditiously, the cable was fitted up in accordance with the fire insurance rules, and gave entire satisfaction.

The Electric Light in the West End.—The new premises of the Bodega Wine Company, in Bedford Street, Strand, W.C., next to the Civil Service Supply Stores, are being installed with the electric light by the Electric Supplies and Fittings Company, Limited, of 42, Duke Street, S.W. The same company are also engaged in fitting up an installation in some new premises at No. 79, Chancery Lane, W.C.

Change of Address.—Mr. Killingworth Hedges, C.E., has removed his offices from 6, Storey's Gate, Westminster, to 7, Carteret Street.

CITY NOTES.

The Kensington and Knightsbridge Electric Lighting Company, Limited.

THE ordinary meeting of the company was held last night. A full report will appear in our next issue. The following balance sheet was presented. The directors' report of the position of the undertaking at the end of the year 1891 states that the mains, which extended for a length of ten miles in the previous year, have been increased during the year 1891 to 12½ miles. During the year the number of houses and shops connected with the system has increased from 291, on December 31st, 1890, to 436, on December 31st. 1891; while the number of lamps calculated on the usual basis of 8 candle-power, has increased from 25,535 to 38,408. The plant at the company's stations has been worked at a greatly increased rate of efficiency, especially during the last half-year, and further improvement in this respect is still being made. Provision has been made at Kensington Court for fixing a new boiler, and at Chapel Place three new engines have been added during the year to meet the rapid increase in the demand at this station. The funds required by the company for extensions during the past year have been raised by the issue of 4½ per cent. debentures, and it has not been found necessary to issue any of the second preference shares authorised at the last meeting. The dividend on the 6 per cent. preference shares was duly paid on June 30th, 1891, and out of the balance standing to the credit of the net revenue for the year 1891, £3,810 11s. 3d., the sum of £1,462 10s. has been appropriated for the payment of the preference dividend to that date, leaving £2,348 1s. 3d., out of which it is proposed to pay a dividend on the ordinary shares at the rate of 2 per cent. for the year, carrying forward £848 1s. 3d. to the next account. In accordance with the articles of association, Mr. A. S. Bolton and Sir Frederick J. Bramwell, Bart., F.R.S., retire from the directorship, and, being eligible, offer themselves for re-election. The auditors, Messrs. Lovelock, H. W. Whiffin and Dickinson offer themselves for re-election.

ABSTRACT OF ACCOUNTS TO DECEMBER 31ST, 1891.

REVENUE ACCOUNT.

DR.	£	s.	d.
To Generation of electricity } ... ... Distribution of electricity }	4,448	0	8
„ Proportion of rents, rates, and taxes	758	8	3
„ Proportion of management expenses	959	1	4
„ Proportion of law and parliamentary charges ...	686	19	11
„ Sinking fund	104	2	0
„ Renewal account	1,850	0	0
„ Balance	4,381	17	9
	£13,188	9	11

Cr.	£	s.	d.
By Sale of current per meter } under contract }	12,266	16	10
„ Rental of meters, converters, &c.	439	17	2
„ Transfer fees and rent receivable	187	2	6
„ Other items	294	13	5
	£13,188	9	11

NET REVENUE ACCOUNT.

Dr.	£	s.	d.
To Dividends at the rate of 6 per cent. on first preference shares, June 30th, 1891	1,301	11	8
„ Interest on debentures and temporary loans ...	171	9	0
„ Balance	3,810	11	3
	£5,283	11	11

Cr.	£	s.	d.
By Balance from account, less first preference dividend to December, 1890	881	3	11
„ Balance from revenue account	4,381	17	9
„ Interest	20	10	3
	£5,283	11	11

RESERVE FUND.

Dr.	£	s.	d.
To Maintenance of plant, buildings, mains, &c. ...	1,535	9	1
„ Balance as per balance-sheet	1,713	5	0
	3,248	14	1

Cr.	£	s.	d.
By Balance from last account	1,398	14	1
„ Amount brought from revenue account	1,850	0	0
	£3,248	14	1

GENERAL BALANCE-SHEET.

Dr.	£	s.	d.
To Capital account	132,930	0	0
„ Sundry creditors on open accounts	11,347	16	2
„ Reserve fund account	1,713	5	0
„ Net revenue account, balance at credit thereof ...	3,810	11	3
	£149,801	12	5

Cr.	£	s.	d.
By Capital account	140,413	19	7
„ Cash at bankers }	1,829	6	9
„ „ in hand }			
„ Sundry debtors for current	5,353	18	1
„ Stores on hand	905	0	8
„ Preliminary expenses and cost of debenture issue	750	3	6
„ Consols	549	3	10
	£149,801	12	5

Electric Construction Corporation.

A GENERAL meeting of the holders of the founders' shares in the Electric Construction Corporation, Limited, was held last Thursday, March 3rd, at Worcester House, Walbrook, Mr. Spencer Balfour, M.P., in the chair.

Mr. W. SAMSON (the secretary) read the notice convening the meeting.

The CHAIRMAN: Gentlemen,—You are all aware of the circumstances and conditions of this meeting. This is not a general meeting of the shareholders of the company—that is to be held a little later on. This is a meeting of the holders of founders' shares, who, under the terms of the memorandum and the articles of association, have to be consulted as to the steps which we propose to ask you to take and increase the capital of the company. The reasons for that increase have been stated in the circular which has been sent to shareholders. I am glad to say that since the last general meeting of the company—which I think we shall all agree was of a very satisfactory character—and since the publication of the report and accounts, which I think you will also agree were likewise of a very satisfactory character, the business of the company has very largely increased. There is, without wishing to use any terms of exaggeration, something like a spurt or boom in the orders for very heavy electrical plant. Now, as was stated at the general meeting, the capital of the company was already fully employed, and I am told by Mr. Parker, our very able and successful works manager, that at the present moment we have in hand orders equal to at least one-half of the whole of last year's work.

Mr. PARKER: Mr. Chairman, that is not quite sufficient; I think you will allow me to correct you. The work we have in hand to-day, and that which we have already delivered, is more than twice that which we did last year.

The CHAIRMAN: I am very glad to hear that. My business is not to exaggerate, but rather to under-estimate our prospects. I am very glad to have that correction from Mr. Parker, but, taking it at even the modest statement I have put forward, our work in hand to-day equals the whole of the work which we had in hand in the six months of last year. You will see, therefore, that the additional capital can be employed to very great advantage. We now propose to ask the founders—I confine myself now to the founders—to concur in the resolution authorising the additional capital. This is strictly within the terms of the original prospectus. In the prospectus that was issued we stated that as the business of the company was increased, so we should come to the shareholders for additional capital. Well, the business of the company has increased, and is increasing, and in addition to the large orders that we have in hand, and in addition to what Mr. Parker has said, we have before us at the present moment, very large and very paying orders involving a very considerable outlay in the first instance in wages and for machinery, but yielding, as we believe they will, very large and very considerable profits to the company. I think I am speaking the unanimous opinion of the board when I say that never since the company has been established were its prospects anything like so promising or so flourishing as they are to-day. We all take heart with regard to the present condition of the company, and we believe that the founders themselves will be largely benefited by this increase of capital—I am speaking to the founders now and not to the ordinary shareholders—because if, as is probable, we shall issue a portion of these shares at fixed preferential rates below the rate at which the ordinary shares will be entitled to participate in dividend—prior to the founders getting anything—that must be to the advantage of the founders of this company. I am a holder of not less than five founders' shares myself, and the board are also large holders of founders' shares. We have had several questions asked us, and the explanations which we have given have been deemed satisfactory, and I trust we shall have the unanimous approval of the founders with regard to this step. If so, and the promises are fulfilled—as I have every reason to think they will be—I believe that then the founders' shares in this company will prove a very valuable investment indeed. I beg to move the resolutions of which you have had notice, namely:—"1. That the capital of the company be increased to £750,000 by the creation of 25,000 new shares of £10 each, numbered 50,001 to 75,000 inclusive. 2. That the whole or any part of the said 25,000 new shares of the company may be issued with any such rights of preference over the founders' shares, whether in respect of dividend (not exceeding a cumulative preferential dividend at the rate of 7 per cent. per annum upon the amounts credited as paid thereon) or in respect of repayment of capital or both, and with such right of voting and generally upon such terms and conditions in all respects as the company may from time to time by special resolution determine."

Continuing his remarks, the CHAIRMAN said: I may anticipate a question which may be put hereafter as to how we propose to raise this capital. Of course we do not propose to issue £250,000 of additional capital at once—that is not in contemplation—but it is not worth while to incur the expenses of meeting continually for the purpose of raising additional capital. We propose to get powers to go up to £250,000 new shares, but probably we shall be content with considerably less than that in the first instance. I look forward to issuing £50,000, or at the outset £100,000, which is quite sufficient for our purposes at present; and when we have proved the success of these orders, and brought the company to a still more prosperous condition than it is to-day, then we shall probably issue the remainder, perhaps as ordinary shares, giving the founders and ordinary shareholders the right to take them at par. But in the first instance we propose to take powers to raise capital not to exceed £100,000.

Sir DANIEL COOPER, a director, seconded the motion. He said he was a founder holding five shares, and also a considerable holder of ordinary shares, and unless he had been firmly convinced that it was absolutely necessary for the company, to get into the successful condition such as they anticipated when they began to form it, to raise this additional capital he would not have agreed to it. He hoped the resolution would be carried without opposition.

The CHAIRMAN then put the resolution, which was carried unanimously.

An extraordinary general meeting of shareholders of the company was subsequently held, Mr. Spencer Balfour, M.P., again presiding.

The CHAIRMAN moved the adoption of the following resolution:—"That the capital of the company be increased to £750,000 by the creation of 25,000 new shares of £10 each, numbered 50,001 to 75,000 inclusive." He said: As regards this particular capital, the board are not committed to any plan for raising it, and it is not in contemplation to raise it directly. We only propose to take powers to go up to the amount stated. £50,000 or £60,000 could be employed to very great advantage, and the rest of it later on, as we make further progress. No steps will be taken with reference to the mode of raising it without calling a special meeting of the shareholders to consider it. The board are anxious to take you all into their confidence, and to have your full support and concurrence. I shall be glad to answer any questions you may wish to put to me.

Mr. COURTENAY seconded the resolution.

A SHAREHOLDER asked the chairman what his idea was as to the mode in which the additional capital should be raised.

The CHAIRMAN said the proposal before the meeting was simply to raise the capital of the corporation. As to whether it should be done by means of preferential or ordinary shares, and how much should be paid up, that was to be decided entirely in the future. The board were not committed to any view on the subject, but would come before the shareholders again with the proposals as to the best mode of doing it. In the mean time they would consider the various methods on their own merits, and recommend that for adoption which they considered best in the interests of the corporation.

The resolution was then carried unanimously.

Mr. CARRUTHERS WAIN moved a vote of thanks to the chairman, and said it was because they had so much confidence in him that they had passed the resolution. They hoped that the increase of capital would be to the best interest of the company, and that the increase of business would also mean an increase of dividend.

Dr. DRYSDALE seconded the motion, which was carried.

Liverpool Electric Supply Company, Limited.

THE annual ordinary general meeting of the shareholders of this company was held last Friday at the Law Association Rooms, Cook Street; Mr. A. H. Holme, chairman of the directors, presiding.

The report of the directors on the working for 1891 stated that the amount of net profit available for dividend, including the balance brought forward from last year, was £7,866 14s. 9d., out of which they recommended payment of a dividend of 4½ per cent. per annum, absorbing £6,580, adding £500 to the reserve fund, and carrying forward the balance to next year's account. They considered the time had arrived when, in addition to writing off depreciation, a provision should be made for the renewal of mains and plant which might be necessary in the future, and they had, therefore, initiated a renewal fund, to the credit of which they had passed a sum of £1,500. The expenditure on capital account during the year (including a proportionate charge for general expenses) had been £17,122. The demand for electricity continued to increase, and the number of lamps connected with the company's supply mains on December 31st, 1891, was equivalent to 14,966 lamps of 16 candle-power each. During the year provisional orders had been granted to the company by the Board of Trade for an additional area in Liverpool, including London Road, Prince's Road, and Prince's Park, and also for an area under the Toxteth Park Local Authority, including Sefton Park and the adjacent residential districts. Both these provisional orders were for the full statutory term of 42 years. The directors had obtained the consent of the Watch Committee, subject to confirmation by the City Council, to a provisional order under which the date for compulsory purchase on the terms of the Electric Lighting Acts of the company's undertaking authorised by the provisional order of 1889 was postponed from 21 to 42 years; the corporation to have the option of taking over the company's supply business in the City of Liverpool as a going concern after December 31st, 1897, at a price to be fixed by arbitration, as in the case of property taken under the Lands Clauses Consolidation Acts.

The CHAIRMAN: in proposing the adoption of the report and balance-sheet, proceeded to explain the position of the company in further detail. He first observed that their business had since the previous year very materially increased. Their prospects also were exceedingly good. People were beginning to appreciate the electric light, and he was glad to say that with increasing business they had made increased profits. The dividend proposed had been fairly earned. Some shareholders might say that they should have declared a dividend of 5 per cent., but they were anxious to do nothing which would injure the future of the company. With regard to the renewal fund, it was certain that the wires did deteriorate to some extent, although not through the passage of electricity, and, besides that, the advance of electric science might make necessary improvements which at present they could not forsee. The expenditure on capital account was due more particularly to the extension along Rodney Street and Mount Pleasant. It had been fully justified. Last year the number of lamps was 11,750. This year the number was 14,966, and at present they had orders which would increase the total to 16,900. That, he thought, very satisfactory. As to the provisional order for the additional area, it was for that area that they were making a call of 10s. a share. That would bring in £17,000, which would be nearly all absorbed in an extension proceeding in one direction through Abercromby Square and along Bedford Street to Prince's Road, and in the other towards University College and London Road. In all those districts they had considerable promises from people anxious to use their light, and he thought that next year the shareholders would say that the expenditure was justifiable. He came next to a matter of great importance, and one which had cost the directors some anxiety. After somewhat protracted negotiations with the corporation through the Watch Committee, they had come to an arrangement, which the previous day was confirmed by the council, and in consequence of which the shareholders might consider that for 42 years their undertaking was their own property, and could not be taken over by the corporation except on terms which were satisfactory to the company, and would give them a fair return for the money they had expended. It was one of those happy agreements by which everyone benefitted mutually, for by it their consumers got electricity at a much lower price than they could have obtained it otherwise. In various matters the corporation were really very hard people to deal with. They had made the company pay a large sum for reinstating the streets. He hoped, however, the corporation would follow the example of other cities. In Manchester, Birmingham, London, and even in Bootle, town halls and public buildings were lighted by electricity, and it was to some extent scandalous that, with the lovely rooms at the Town Hall, Liverpool should continue the old-fashioned arrangement of gas. At the same time the corporation had instructed their engineer to report on the matter, and no doubt the effect would be that the company would increase its business to that extent.

Mr. D. DE YBARRONDO seconded the motion.

Mr. JAMES LISTER congratulated the directors on their report, and spoke of the arrangement with the corporation as most satisfactory. He also commended the formation of a renewal fund, and suggested that, in view of the state of their accounts, the dividend might be paid free of income tax.

Mr. C. BIRCHALL supported this suggestion, remarking that, including the £1,500 set aside for renewal, the company had made during 1891 a profit of £9,000. He called attention to the price of electric lamps, remarking that a reduction in their cost would greatly contribute to bringing the electric light more into favour.

A SHAREHOLDER having enquired if, under the agreement with the corporation, 7 per cent. was not the maximum dividend allowable?

The CHAIRMAN, in reply, said the directors accepted Mr. Lister's suggestion. As to the lamps, the patent for them expired next year, and they would then be produced for about 1s. 3d. a-piece, instead of from 4s. to 5s. as at present. The arrangement with the corporation was that all profits over 7 per cent. were to be divided equally between the shareholders and consumers.

The report was then carried.

On the motion of Sir D. RADCLIFFE, seconded by Mr. DRANSFIELD, the retiring directors, Messrs. A. H. Holme and D. de Ybarrondo, were re-elected.

Mr. JAMES LISTER proposed, Mr. T. GOFFEY seconded, and it was decided to increase the remuneration of the directors from £300 to 400 guineas.

Mr. W. L. JACKSON was re-elected auditor.

The CHAIRMAN afterwards submitted a resolution approving of the provisional order now being promoted by the company before the Board of Trade, and accepting the amendments agreed upon between the company and the corporation. He commended the manner in which the legal business in this matter had been carried out by Mr. F. M. Radcliffe, their solicitor.

Sir D. RADCLIFFE seconded, and the motion was at once agreed to.

A vote of thanks to the Chairman concluded the proceedings.

Hobart Tramway Company, Limited.—This company has been formed with a capital of £105,000, divided into 105,000 shares of £1 each. 60,000 shares have been issued, the remaining 45,000 being held in reserve for the debenture holders, if at any time they should elect to exchange their debentures for shares. 20,000 shares will be allotted as fully paid to the vendors, and the remaining 40,000 shares are offered for subscription. Applications are also invited of £30,000 first mortgage debentures, divided into 1,500 debentures of £20 each, at par; and £15,000 second mortgage debentures, divided into 750 debentures of £20 each, at 95 per cent. The company has been formed to acquire the Hobart Tramway, and to fully equip and work it by electric power. Offices of the company (pro tem.): College Hill Chambers, Cannon Street, E.C.

The "Eston" Arc Lamp Syndicate, Limited.—This syndicate has been formed with a capital of £25,000, divided into 5,000 shares of £5 each. The first issue of 2,200 shares at par, are offered for subscription. The objects of the syndicate will be to acquire the patent rights of Messrs. Crampton & Essinger, in England, Germany, France, Belgium, Austria, Spain, Italy, Switzerland, Canada, and the United States of America, for "Improvements in electric arc lamps." There are several valueless statements respecting the advantages of the lamp contained in this prospectus, and, considering similar inventions now in the market, we deem the price to be paid for the patent rights unwarranted by the probable demand, present or prospective.

The Maxim Weston Electric Company, Limited.—A general meeting of the members of the above-named company will be held on April 8th, 1892, at the Cannon Street Hotel, in order that there may be laid before the members an account showing the manner in which the winding up has been conducted, and the property of the company has been disposed of, and in order that the company may hear any explanation that may be given by the liquidators. Another general meeting of the members of the company will be held on the same day for a similar purpose.

Oriental Telephone Company, Limited.—The directors of this company have resolved, subject to audit of the accounts, to recommend to the shareholders a similar dividend to that paid last year, viz., at the rate of 2¼ per cent. on the entire paid up capital of the company, which dividend being only payable to the holders of ordinary shares, is equivalent to £3 12s. 2d. per cent. on each share of 11s. paid.

Brazilian Submarine Telegraph Company, Limited. The directors of this company have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended December 31st, 1891, and payable on the 25th inst. The books of this company will be closed from the 18th to 24th inst., both days inclusive.

Western Union Telegraph Company.—A New York telegram states that the Western Union Telegraph Company has declared a quarterly dividend of 1¼ per cent.

Commercial Cable Company.—A quarterly distribution at the rate of 7 per cent. per annum is to be paid on April 1st.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The receipts for the month of February were £3,600 as compared with £3,418 in the corresponding month of last year.

Direct Spanish Telegraph Company, Limited. The estimated traffic receipts for the month of February, 1892, are £1,865, as against £1,953 in the corresponding period of last year.

The Great Northern Telegraph Company. Receipts in February 1892, £30,800; 1st January—29th February, 1892, £40,800; corresponding months 1891, £41,600; corresponding months 1890, £39,400.

The West India and Panama Telegraph Company. The receipts of the West India and Panama Telegraph Company for the two weeks ended February 29th, show an increase of £122 as compared with the corresponding period.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (March 3rd.)	Closing Quotation. (March 10th.)	Business done during week ending (March 10th, 1892. Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Debs. Regd. and to Bearer	100	99 — 102	99 —102	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	49 — 50	49 — 50	49	...
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	88 — 89	88 — 89	89	88½
2,849,510*l*	Do. do. Deferred	Stock	11⅜— 12¼	11½— 12¼	12	11½
130,000	Brazilian Submarine Telegraph, Limited	10	10¾— 11¼	10¾— 11¼	11 3/16	10⅞
53,200*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	104 —108	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3⅛— 3⅜	3⅛— 3⅜	3 7/16	3 3/16
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2¼	2 — 2¼	2¼	2⅛
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½— 3½	2½— 3½	3¼	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	10	8 — 8½	8 — 8½	8 7/16	8¼
$7,716,000	Commercial Cable, Capital Stock	$100	152 —157	155 —160	159¼	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	⅜— ½	⅜— ½	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½ — 6	5½ — 6	5⅞	5 9/16
16,000	Cuba Telegraph, Limited	10	10 — 11	10 — 11	11	10½
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	16¾	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¼— 3⅜	3¼— 3⅜	3½	...
6,000	Do. do. 10 p. c. Preference	5	8½— 9½	8½— 9½	...	...
60,710	Direct United States Cable, Limited, 1877	20	11 — 11¼	11 — 11¼	11⅛	11 1/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜— 14⅝	14⅜— 14⅝	14⅝	14½
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15½	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	105 —108	106 —109	108	107½
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 — 110	108 —111	109¾	108½
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14¾— 15⅛	14⅝— 15⅛	15⅛	14⅞
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	102 —105	103	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	103	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	106 —109	106 —109	107½	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	101 —104	102	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	101 —104	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —102	99 —102	101¼	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5½— 6	5⅝— 6¼	6¼	5⅞
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ..	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	2½— 2⅝	2½— 2⅝	2 7/16	2¼
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅞— 3⅛	3 — 3¼	3⅛	2⅞
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1⅜— 1⅝	1⅜— 1⅝	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅞— 10⅛	9⅞— 10⅛	10⅛	9 13/16
180,042	Do. do. 6 p. c. Preference	10	14⅝— 15⅛	14⅝— 15⅛	...	...
150,000	Great Northern Tel. Company of Copenhagen	10	18¾— 19¼	18¾— 19¼	...	...
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108 xd	105 —108	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	7¾— 8¼	7¾— 8¼	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	12½— 20½	19½— 20½	20¼	19⅞
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —106	103 —106	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	3½— 4½	3½— 4½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8 — 9	8 — 9	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	2⅝— 2⅞	2⅝— 2⅞	2¾	2⅝
10,000	Do. do. fully paid	5	4¾— 5	4¼— 5	4⅝	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	103 —106 xd	105 —108	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	8½— 9	8¾— 9	8 15/16	8⅝
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅛— 4⅜	4⅛— 4⅜	4 5/16	4 1/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	13 — 13½	12½— 13½	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	11½— 12½	11½— 12½	...	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	104 —107	104 —107	106¼	105¼
250,000*l*	Do. (issued at 5 p.m., all paid)	...	54 — 57	79 — 81	...	...
6,318	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	4½— 5½	4½— 5½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	¼— ⅜	¼— ⅜	...	...
9,000	Reuter's Limited	8	7½— 8	7½— 8	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8¼— 8¾	8¼— 8¾	8½	8¼
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7¼— 7¾	7¼— 7¾	7⅝	7½
3,381	Submarine Cables Trust	Cert.	116 —121	117 —122	117½	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4 — 4½	4 — 4½	4⅜	4 3/16
37,350	Telegraph Construction and Maintenance, Limited	12	45 — 47	44 — 46	46¼	45
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	1 — 2	1½— 2½	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	80 — 90	80 — 90	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	7 — 8	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	99 —102 xd	99 —102	100¾	100
30,000	West Coast of America Telegraph, Limited	10	4 — 5	4 — 5	4¼	4
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	102 —106	102 — 106	104½	104
67,007	Western and Brazilian Telegraph, Limited	15	10 — 10½	10 — 10½	10 7/16	10⅛
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	6⅜	6⅛
30,364	Do. do. do. 5 p. c. Deferred	7½	3¾— 4¼	3¾— 4¼	...	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	101 —104	102 —105	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	101 —104	102 —105	...	...
88,321	West India and Panama Telegraph, Limited	10	1½— 1⅝	1⅝— 1⅞	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9¾— 10¼	9¾— 10¼	10⅛	10
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8½— 9½	8½— 9½	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	99 — 103	99 — 103	...	...
£1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	97 —100xd	97 —100	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6 — 6½	6¼— 6¾	6 9/16	6½

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7⅛—7⅜.—Electric and General Investment, shares of £5 (£1 paid), 2—2½.—Founders' shares, 150—200.—Elmore Foreign and Colonial Copper, Founders' shares, 6⅜—7⅛.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable, 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 4¼—5.—7 per cent. Preference Shares of £5 (fully paid) 5⅛—5⅜.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅜—6, 1st Preference Cumulative 6 per cent., £5 (fullypaid), 5⅛—6.—Liverpool Electric Supply Shares of £5 (fully paid), 4⅜—5.—Do. shares of £5 (£3 paid), 2⅜—2⅝.—London Electric Supply Corporation, Ordinary (£5 paid), ⅞—1⅛.—Do. 6 per cent. Preference, 1⅛—1⅜.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—⅜.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—⅛.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—⅛.—Do. Debentures, 103—⅛.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ⅛—1.—£5 Preference (fully paid), 2⅛—2⅜.—Ward's Electric Car (£10 paid), 1⅜—1⅝.

BANK RATE OF DISCOUNT.—3 per cent. (January 21st, 1892).

LEGAL.

Lane-Fox v. Kensington and Knightsbridge Electric Lighting Company.

(*Continued from page* 305.)

WEDNESDAY, MARCH 2ND, 1892.

PROF. BARRETT, before being cross-examined by Sir Horace Davey, said he wished to qualify or correct an answer he gave yesterday. Sir Horace Davey was asking him the meaning of the term very large cells, and he (witness) had in his mind at that time the comparison between his own installation and the small Planté cells which were in his possession; but in connection with the specification, the words "very large conducting surface" had a definite meaning in addition to that which he gave; it obviously meant that the cells should be relatively large compared with the installation. He based that answer on the words in the specification: "The cells should have a very large conducting surface, and there should be several batteries connected up at various points of the mains, so that by increasing the electromotive force during the hours when not much electricity is being used, they will become charged, and a sufficient supply will be available when the electromotive force falls, owing to the draft from the mains."

Sir HORACE DAVEY: That means large enough to supplement the current from the dynamo when the current from the dynamo is insufficient?—Undoubtedly that is the use of the batteries, to increase the quantity of electricity; but another and an important use is to keep the pressure constant.

You agree with me that the patentee does not give any measure by which one can measure the size of the conducting surface other than that it is to be sufficient to supply a large current?—He gives no definite measure, but I take it an intelligent and skilled workman in 1878, who would understand simple arithmetic, would know that the current is equal to the electromotive force divided by the resistance (a perfectly well known law in 1878), and would have been able to make his batteries of sufficiently large surface to give the requisite current with a small difference of pressure.

If you wished to have a particular kind of storage battery, it would have been easy to say it must be a storage battery of so many ampères or webers to the square foot?—I think the general instructions contained here would have been quite sufficient for an electrical engineer to carry the installation out properly.

Your dynamo can produce from 16 to 18 ampères?—Yes.

Do you ever need a larger current than your dynamo can supply?—Yes, for a short period, and then the batteries are used for storage purposes.

Do you use an Otto engine—I think you told me you did?—Yes.

In which there is a perceptible pulsation?—Yes, and the batteries correct that.

Have you ever lighted your lamps from batteries without the use of the dynamo?—Yes, simply to save trouble. When we want it for a short time we have a store of power.

Have you measured the drop in potential during that running of the batteries alone?—I cannot call to mind any experiment as to that.

The use you make of the secondary battery is chiefly as a governor?—That is my chief use.

When your installation was put up the chief practical use of electricity was for the purpose of telegraphy?—By no means; it was used for electro-plating and electric arc lighting.

In practice, what you called e in your laboratory would be the actual earth, would it not?—I used e for a return conductor; I used a return wire as more convenient than the gas or water pipes.

You will probably agree with me that it is dangerous to argue from laboratory experiments when applied in practice on a large scale?—I think the terms big and little have little meaning for scientific men. For scientific men the laws are the same whether on a big or small scale.

It may be that on a large practical scale there are other laws which come into operation?—I have not found it so.

You agree that practical experience is of great value?—Yes, in every vocation of life.

Re-examined by Mr. MOULTON, WITNESS said that though he did not use Mr. Lane-Fox's lamps, the principle upon which the superiority of the modern lamps depended was described by Mr. Lane-Fox, who was very considerably in advance of the general knowledge at that time. With the exception that there was now a better mode of protection than nitrogen gas, namely, a vacuum, and a better substance than iridium for the conductor, namely, carbon; no change had, in his opinion, been made in the lamps. Whether or not regulation were pointed out in the specification, regulation was a necessary consequence of the plaintiff's invention as described in his specification. Many batteries were electrically the same as a big one. Many batteries placed at different points in the mains were more advantageous than a big one equal to them in size.

Prof. GEO. FORBES, Fellow of the Royal Society, Member of the Institutions of Civil and Electrical Engineers, and of many other societies, said he had been engaged in the practical application of electricity for 20 years, and had acted as consulting engineer to various electrical companies. That which was claimed by the plaintiff was certainly novel and very useful. In his opinion the lamps now used were of the same class as those described by the plaintiff. The plaintiff's system would work with his own lamps, but it would work with the present lamps much better. The great change was the putting in of a carbon filament instead of platinum or iridium. In 1878 "earth" meant the return route or conductor whatever that conductor might be. Their measuring instruments were generally marked with one of the binding screws *earth* or e, and they always connected a wire from that binding screw to the common return. Any electrician would know that he could substitute another conductor for earth if he so wished. There was no novelty in a complete metallic circuit—it was every day experience. If an engineer could not get enough connection with the earth, the obvious thing for him to do would be to use a metallic conductor. He knew of no previous patent for keeping constant the current in the mains. The remainder of the witness's evidence was a corroboration of that given by previous witnesses, with the addition that, with regard to Mr. Crompton's failure in the Law Courts, he said that if the batteries and dynamos were going and the lamps were only dull red, he drew the conclusion that the batteries were insufficiently charged; while if when charging the batteries the lamps burst, he drew the conclusion that having to make up for the deficiency, the batteries were drawn upon and more pressure put on them than would be necessary in the ordinary working.

Cross-examined by Mr. FINLAY, Q.C., WITNESS said he did not read Mr. Lane-Fox's specification as saying that it was essential that the secondary batteries should be scattered about up and down the system. Mr. Lane-Fox meant it was a desirable thing.

Do you think it would be a good plan to keep an attendant at each secondary battery throughout the district engaged in switching off and switching on?—That would be feasible.

That would be somewhat expensive?—No; a boy is not a very expensive luxury.

Don't you know the defendants use secondary batteries only at their Kensington station and at the Queen's Gate station where the secondary battery is connected directly with the dynamos?—I believe that is the arrangement; the batteries are connected directly on to the mains.

Our feeders are not connected with the mains when they are being charged?—I did not know that.

Do you know the system of feeders the defendants employ for preventing the loss of electricity in the transit along the mains?—Oh, yes.

Do you think there is anything in the plaintiff's specification indicating a means of achieving that end by another machinery?—There is to a certain extent, but it is by exactly the same machinery. The idea is to put the batteries to supply the mains at different parts. The introduction of feeders is an addition, and an important addition.

Do you know the defendants use secondary batteries for storage at their secondary station?—I do not know how they use their feeders. I thought they were being charged at the moment they are supplying the current to the lamps.

Mr. JUSTICE SMITH: The point between you is, you say you are using the batteries for storage only, and they say you are using them for storage plus regulation.

Mr. FINLAY: Where the load is being carried along the length of the mains there is a loss of voltage?—Yes.

Is not the object you contemplate, when you say there is a regulating power at the secondary battery, that the whole loss by resistance may take place in the feeders, and the voltage at which the lamps at each point are supplied may be approximately equal?—I really do not know sufficiently well the defendants' system.

Mr. JUSTICE A. L. SMITH: Do you know of any system of lighting by electricity by which a person may work without secondary batteries being attached to the mains?

WITNESS: I have heard of electric lighting being done without batteries at all.

Mr. FINLAY: You know there are no secondary batteries used in these courts?—I do not know.

Are there not more systems without secondary batteries than with?—There are plenty of systems without secondary batteries.

Rather more known without secondary batteries than with?—Not in this country.

When in 1885 you advocated dispensing with secondary batteries altogether, did you then consider that they were necessary to insure steadiness of the light?—I was convinced they would produce a greater steadiness of light.

Do you consider them necessary?—I do not consider them necessary now. By an expensive system of working and enormous care, I believe you could get perfect steadiness.

In reply to a question by Mr. JUSTICE A. L. SMITH, WITNESS said that he did not think he could mention a low tension continuous current central station without batteries.

Mr. FINLAY: Has it not been found practica le to get steady lights without secondary batteries?—I have not seen it.

You have seen the lamps in these Courts?—They are very unsteady; they have varied from 15 to 20 volts during the last few days, at the time they were supposed to be in steady working.

In 1885 you said that charging a battery with too weak a current was injurious?—I did, but I have since said I was wrong there.

Does not thoroughly charging mean charging up to the bubbling point?—No, a skilled electrician would always use an hydrometer, which would tell him when the battery was properly charged. When the acid comes up to 1,200, you know the battery is properly charged.

The ATTORNEY-GENERAL, entering after the adjournment for lunch, which took place at this stage, said that he understood a question had been raised as to the infringement, that was to say as to whether or not the secondary batteries were used at Kensington at the same time they were running the engines and the lights were on. If there were any question as to that he must ask leave to recall his witnesses, both Mr. Lane-Fox and Prof. Silvanus Thompson.

Mr. JUSTICE SMITH said that when the defendants' witnesses had been heard and cross-examined he would, if necessary, accede to the Attorney-General's application, in order to enable him to meet the point.

Mr. FINLAY said that probably it would be found that there was no difference of fact; if there were, of course his friend's witnesses could be re-called.

To the witness: In 1878 was it not known that for an incandescent lamp a tolerably constant pressure was wanted?—I had no knowledge of incandescent lamps in 1878.

They were not unknown?—I did not know anything of them.

With regard to the distinction between "the earth" and "earth," witness was of opinion that an electrician would say the soil, if he meant the soil; if he used "earth" it would include a return by the soil.

Mr. JUSTICE A. L. SMITH: Supposing I come to the conclusion that "the earth" meant the soil, am I not at liberty also to say that a man of experience would use anything he could get?

Mr. FINLAY: Your Lordship will determine that according to the evidence. We have a considerable amount of evidence on the point.

Mr. JUSTICE A. L. SMITH: I know.

In re-examination by Mr. MOULTON, Q.C., WITNESS said that dynamos had been improved enormously since 1878. Even now secondary batteries put on the mains would make the light steadier. The "darkest hour" of secondary batteries was when the old Planté had been forgotten and the new Fauré had proved unsuccessful.

This was the plaintiff's case.

The case for the defendant company was then opened by Sir HORACE DAVEY, Q.C., who said that he would state as concisely as possible the points on which he intended to rely before he proceeded to argue on them. In the first place, the defendants said that the plaintiff's was no invention, that the so-called invention merely consisted of putting side by side two known things, each of them separate and intending to operate in the old manner and not in any new manner—that there was no application or directions, no invention shown in the manner of the combination; that it was, in fact, merely putting two known things side by side, each of them operating in the way in which they were always accustomed to act. Secondly, the defendants said that the combination, as a combination, had been anticipated both by Clarke and by Achard, that it was a combination for supplying electricity by a joint connection of a generator, a source of electricity, and a secondary battery for the purpose of sending a current through for particular use at a particular point; that that was exactly the combination described both in Clarke and Achard, and that it did not make the slightest difference for what purpose the current of electricity was used which was obtained by that means, whether it was used for electric lighting or for brakes on railway engines, or for lighting a match or for bells—whatever it was it consisted of passing a current of electricity through for use at that required point. Thirdly, the defendants said that the so-called invention as described in the amended specification was useless for any practical purpose. It was useless for the purpose for which it was described, because, in the first place, the direction to carry the return wire to "the earth" was absolutely impracticable, even if the Court indulged his learned friends to the extent of saying that that meant an insulated conductor, though the defendants submitted that must be read in the ordinary sense which those words bore. The defendants also said that the alternative mode of connecting it with the earth by means of gas and water pipes had been found practically mischievous and unworkable; and evidence would be given to that effect. But, shortly, the defendants said that without a system of extra cells and switches for switching out and bringing into use these extra cells, and a nice adjustment and adaptation of the current which was used for the purpose for which it was used, it was impossible to work what was described in Mr. Lane-Fox's specification for the purpose of storing electricity to be used when wanted to supplement the main current from the dynamo. Upon that point he should show his Lordship that his learned friends had deliberately ignored and left out of sight what the patentee himself said was the object of his invention, and had fixed their attention, and endeavoured to fix the attention of the Court, upon that which was not described in the specification, but which was at the most an incidental advantage (if it were an advantage) of what was described. The patentee, according to his (Sir Horace's) view, described—and very clearly described—a system by means of which electricity was to be stored up in a reservoir, and to be taken out of the reservoir to be used for the purpose of supplementing the current in the dynamos when there was a load on the mains. As Mr. Lane-Fox told them in his paper before the Royal Institution, the object was to enable a large number of lamps to be lit with a plant which would be too small for the purpose if it were used alone, but which could be supplemented by electricity stored up in the batteries. It might be Mr. Lane-Fox's patent had the incidental advantage of what his learned friends had been talking of for seven days, namely, of regulating the electromotive force of the current; but if it did, that was not what the patentee described: it was an incidental advantage not invented by the patentee, but which was, as Prof. Barrett said, inherent in the thing itself. A man could not take out a patent for discovering a new application of an old thing. If you used your Planté batteries as reservoirs for storing electricity, you also gained the advantage of regulating your dynamo. On that part of the case, he said that whatever might be Mr. Lane-Fox's suggestions, they remained in that region and did not go beyond it; they were crude suggestions stated without details, which were unworkable, and even now remained crude suggestions without any sufficient description or directions for enabling them to be carried out in the form of a workable machine, and suggestions which left the details to be worked out by the experiment, he thought, and the attention and the invention of the man who had to work them out. With regard to insufficiency of description, there were two principal grounds on which the defendants attacked the insufficiency of the specification. First, that the patentee directed the use of very large conducting surfaces in his cells. That had assumed an importance which it did not possess before this case was opened. The plaintiff said "*A very large conducting surface.* That ought to have told you you ought to use conducting cells so much in excess of what would be required to carry your current as to enable you to charge and discharge without raising the voltage." It was for the Court to say what the meaning of that was. The defendants said that if that were so, and that were the meaning of the patent, it was incumbent on the patentee to tell them how large, to give them some relative measure; for instance, so many ampère hours for each square foot, something which a skilled person would have understood. But to leave people with the mere direction that it was to be very large, large being a relative term, was not to tell them what the patentee had in his mind, and it could only be discovered—if it could be discovered—by experiment and invention. In his view that point had been evolved out of the moral consciences of his learned friends and their witnesses, as the case proceeded, and had, in fact, become the whole point in the patent. The defendants also said there were no directions for using extra cells. As the case gradually developed his learned friend, in order to avoid the pressure of what was put to their witness—also said, "But you are not to charge fully and discharge fully." On the contrary, inasmuch as the patentee mentioned the purpose for which the batteries, namely, for storing electricity, the mind of the person into whose hands this patent was put would be led towards using the batteries to their full storage capacities. Instead of there being anything which would lead the mind to say, "You are to imperfectly charge or not to charge your batteries to the full extent, or not to discharge them to the full extent," the whole scope and object of the patent would stamp the mind in a totally opposite direction. The Attorney-General was a great master of phrases. Like all public men, he was fully aware of the great value of a phrase, and he had invented a phrase which did him the utmost credit. But they must not be misled by phrases. The phrase he used was "the plateau." There was nothing about "the plateau" in the specification, nor anything which led in the direction of "the plateau." It might be that his learned friend was quite right, that for the only purpose for which he seemed to think his client's specification was useful (namely, regulation); it might be useful neither to charge nor to discharge fully. Perhaps he was. So far from there being any direction for using extra cells to be put in and out of working, the mind was led in the opposite direction. One was told to use the number of cells which corresponded with the electromotive force.

Mr. JUSTICE SMITH: Which line is that?

Sir HORACE DAVEY: "The number of cells in each battery will depend on the electromotive force of the mains." Continuing, the learned counsel said he put that to Prof. Barrett, who told him that meant that if you had cells the electromotive force of which was 2 volts each, you were to take 50 for 100 volts, and so on. The defendants said that for the purpose of storage it was essential that extra cells should be used which could be put in and out and worked by a complicated arrangement of switching. He did not say there was any invention in making a switch; but there was great invention, great thought, time, trial, and adaptations necessary to obtain a workable system for the purpose of storage with a view to future use, to supplement the deficient current of the dynamos so as to enable one to work with a smaller plant than one would otherwise be able to work with. That would be his case. The defendants said there was no infringement. If he were right in what he should lay before the Court, that this system could not be used for the purpose of storing electricity with a view to future use on the mains when the exigencies of the lamps were very heavy without this system of extra cells, and this nice adjustment and adaptation which would be explained by his witnesses, there was an end of the case; because, whether it were put as want of utility or insufficiency of specification, the two things ran into one another: it might be described as not working for want of these things, or by reason of no sufficient direction being given to the workman to produce the required result, and leaving it to him to find out by thought, experiment, trial, and invention. No gentleman had come there to say that he had ever heard of any application of the plaintiff's combination without a system of switches, with the exception of the laboratory experience of Prof. Barrett, and those two or three hours the lamps were run at Lady Conyers. Originally the installation in the Law Courts was made without any arrangements such as he had described, with the consequence that the accumulators had to be taken away, and Mr. Crompton had to devise the scheme which he had now brought, he did not say to perfection, but to a workable system, and put in force at Kensington. According to the defendants' view, their combination was strikingly different from the plaintiff's; it was a different system altogether. His Lordship had heard there was considerable resistance in the mains, and that it was desirable to overcome that resistance. He (Sir Horace) thought the true reading of the specification was that Mr. Lane-Fox intended those secondary batteries to be put about the system for the purpose of counteracting the resistance in the mains at that point, and so overcoming the loss by resistance in the mains in that way, and making the current constant at that particular point. Whether constant there or at a different point it was immaterial to discuss. That was what his Lordship would hear gentlemen whom, he regretted to say, were not professors, but who were practical men acquainted with the working of these things, tell him what they understood to be the meaning of it. If that were so, the defendants achieved that object in a totally different manner. They had going from their various branches what they called feeders, which light a small portion of the district. Each feeder would light a limited portion of the district, and the feeder was brought back to the main, so as to form a complete circuit. By that means they get rid of the resistance to the mains, because the feeder went straight to the central station at a point where the resistance in the mains had not commenced to lower the potential. That was a totally different way of getting rid of the resistance in the mains from that proposed by Mr. Lane-Fox. In short, his Lord-

ship would hear that the defendants did not use, and did not think these secondary batteries were useful for the purposes of regulation at all. What they wanted them for was to supplement the working of their dynamos, for economy, for enabling them to work with a smaller plant than they would otherwise be able to do; because by employing that plant during the earlier part of the day, when not much light was wanted, they were enabled to store up a quantity of electricity for use at night, in aid of the current from their dynamos. Incidentally, it might have some effect on the regulation; but whether that were so or not, what he said was that it was not for the purpose of regulation. If that were an advantage, it was an incidental advantage, but for the purpose he had named, of cheapening and utilising the plant to the full extent by running all day long.

[The learned counsel here produced a model of the defendants' switching and other arrangements, and explained its working to his Lordship and the opposing counsel and their witnesses.]

Continuing his address, he said they would understand from the model the complicated but beautiful system by which the quantity of the current and the potential was adapted to the needs of the installation, and they would observe that the machinery or apparatus by which it was carried into effect was certainly the outcome of some thought, attention, experiment, and trial. He was far from saying that it was the most perfect way in which this could be carried out, but he affirmed, beyond the fear of being convicted of saying that which is inaccurate, that without some such system as that, the batteries would be incapable of storing up electricity for use when there was a high demand on the mains. He said that for the simple reason that when the batteries were being charged, his Lordship saw that the voltage ran up as high as 140 volts. He would admit that if charged more slowly it would not be necessary to have so high a voltage. But that was immaterial; they must have an excess voltage to charge the batteries. His Lordship would see that the excess voltage on their system was taken up by the batteries themselves, so that no current at a higher pressure than 100 volts could at any time reach the lamps. Comparing that with Mr. Lane-Fox's system, the difference would at once be seen. He would assume that the effect of the evidence was that it required 110 (140?) volts and upwards to charge the batteries in any reasonable time, say 12 hours, so as to deliver a current of 115 volts. On Mr. Lane-Fox's system that 115 volts would go into the lamps. That was as plain as possible. Any lamps which happened to be on during that charging period would receive that excess whatever it was. That was not denied, and that was one reason why Mr. Lane-Fox's system could not be used without some mechanical means of regulating and controlling and keeping it under command. Take it the other way. It was found in experience—and one ounce of fact was worth tons of theory—by the men working these things, that if you let the batteries discharge for the purpose of using the current for the lamps, supplementing the current from the dynamo, or using the current from the batteries alone, that there was a gradual, sensible, susceptible, mischievous drop in the current. Mr. Lane-Fox agreed that there would be a drop in the current which would operate to lower the potential on the whole system. It was to meet that drop in the current, to keep up the current of electricity flowing from the batteries, that the defendants from time to time during that working brought into operation additional batteries which were ready charged. If his witnesses were right in saying that when the discharge took place there was in the first instance a very large drop and then a continuous drop sensible and mischievous, then he should like to know how the thing could be worked so as to produce a constant potential in the lamps, unless you introduced some mechanical means of taking up in the one case that extra pressure, and in the other case of supplementing the potential of the current from the lamps by introducing new cells and new means. Of course, his Lordship would understand he was speaking of the batteries for the only purpose for which the defendants used them—and as he thought for the purpose for which the patentee intended them to be used — namely, for the purpose of storage. This was the branch on that part of the case on which he wished to rely. It seemed to him that the apparatus which he had been describing required some thought, experiment, ingenuity, and invention to introduce. It was a very remarkable thing that in every case where secondary batteries had been used for installations—with the exceptions of Lady Conyers's and Prof. Barrett's—it had been found necessary to introduce switches. He was aware that Mr. Fox said the batteries were so bad. But a patentee knew what batteries were suitable for his invention. What batteries did he use? Sellon and Volckmar's. It was remarkable for the patentee to come now and explain away the failure of every attempt to carry out his system without some such mechanical means as he (Sir Horace) had endeavoured to explain by the inferiorities of the batteries. The fact that the plaintiff's system worked admirably with Sellon and Volckmar's batteries and switches showed that it was the introduction of the switches that got rid of the difficulty. He was certain that if anybody on the continent or elsewhere had used Mr. Lane-Fox's system as described in the specification without switches or mechanical apparatus, they would have heard of it. Therefore, he was entitled to say his learned friends could not produce any case in which secondary batteries had been used in connection with the plaintiff's system of distribution without the addition of this mechanical apparatus. Were all the people who were at Lady Conyers's ball dead? Why was there not somebody to tell them what occurred besides Mr. Lane-Fox? All they knew was that the lights died out. Mr. Lane-Fox suggested that it was in consequence of the connection being broken. It was one of the misfortunes of Mr. Lane-Fox that there was always something happening to interfere with the success of his system. Mr. Lane-Fox did not admit that his schemes failed for the want of working out with sufficient detail to make them successes. At the Law Courts, Mr. Crompton did not know the A, B, C, of electric lighting; Mr. Crompton was notorious; Mr. Crompton was too stupid. (Laughter.) That might be, but Mr. Crompton had put up more installations than any living man in England. Then the workmen were too stupid—they did not understand. What did this all point to? It pointed to the fact that the directions were insufficient. They would all be Lane-Fox's if they could. (Laughter.) Workmen would be stupid, they would not understand—if you did not give them plain directions. But it was idle for Mr. Lane-Fox to come and say that the reason of his failure was because there was a conspiracy against him amongst the directors of the Brush Company who bought these patents for a large number of fully paid up shares, and who were likely to make the most of the property they bought. That was the secret of it. Mr. Lane-Fox was a man of brilliant ability, but unfortunately his was one of those brilliant intellects which would not give themselves the trouble to condescend to particulars, and he had placed before the world a number of crude ideas which might or might not be capable of being made into workable systems, but which in themselves were not worked out in detail sufficiently to enable a workman to take the specification in his hand, and with no more (which his Lordship knew was the test) make a workable system of storing electricity with a view to future use.

MR. JUSTICE SMITH: Do you say that as to regulating.

Sir HORACE DAVEY said that, if the patent were for storing and regulating, if it would not store that was fatal to the patent, although it would regulate. It was necessary for the plaintiff to prove that it would both store and regulate. By a careful analysis he proposed to show the Court that this idea of regulating was absolutely unfounded, that it had been invented, and that the patent had been amended in such a way as to make it appear that the patent was for what his learned friend had called automatic regulation, when the patent which was originally granted for the system of regulation was wholly different. It could not be denied that if a man took out a patent for a mode of regulating the electric light and in his specification a particular detailed mode was shown in which he achieved that object, he could not by amendment strike out the whole because he had discovered that there was an inherent property (as the witnesses had called it) in secondary batteries which would act as a regulator. He could not strike out the whole of his detailed description of his regulator and then say he had still got a patent for regulating the electric light, because what he had described for another purpose would operate as a regulator.

The learned counsel had not concluded his address when the Court rose for the day.

THURSDAY, MARCH 3RD, 1892.

Sir HORACE DAVEY, Q.C., continued his address with an analysis of the provisional and final specifications, and by pointing out what was disclaimed. What the patentee had done, according to his submission, was by retaining the use of words which had a definite exact meaning—described by the patentee in the original specification—to make those words apply to a different invention or suggestion from that which was contained in the original specification. In the original specification he meant regulation by the regulator, which he told them was necessary for the success of his system, with an added recommendation that it was desirable to use a large number of secondary generators and generating machines. He struck out that which he described as the regulator or the necessary regulator, and then said, "I still have a patent for regulating the electric light." How could he? That altered completely the scope of the patent; it made it apply to a totally different thing, and that was entirely beyond the competence of the patentee. He (Sir Horace) confessed that that seemed to him a very material point, both as affecting the validity of the patent as now disclaimed, and also as affecting the cogency and validity of his learned friend's argument. He thought he was right in saying that they put their case entirely on this, that it was a regulation patent. Turning to the original specification, that would be seen to be carefully divided into parts, one part being carefully appropriated to the last head of the title "Regulation," and in that he was told that the only essential part of the regulation was the use of the quadrant electrometer which the plaintiff described in great detail. But the plaintiff now struck all that out, and said, "What my system of regulation is, is not that which I claimed as the essential part in the original patent, but as something which I had not described with reference to the subject matter at all." He (Sir Horace) therefore submitted that this was not a regulation patent at all, and that the attempt, by retaining the word "regulating" in the title and in the preamble of the scheme, would not have the effect of giving the patentee the benefit of this as a regulation patent, as it was obtained by different means from those described as essential to that purpose in the original specification. With regard to the exact words of this specification, in the first part the patentee described a lamp. He agreed that it was intended, in fact, to be an incandescent lamp. It was not necessary to say that the lamp was useless, because it had been disclaimed. But if it were said that Mr. Lane-Fox's lamp was part of the mode of distribution, he was prepared with evidence to show that that lamp never had been, and never could be, put into successful operation. Mr. Lane-Fox, no doubt, stated general principles, but he failed to work them into successful details with regard to this lamp. Mr. Lane-Fox suggested platinum and iridium, but he did not describe the only form of lamp which had been found successfully useful, namely, a lamp with a carbon filament conductor enclosed in a vacuum. That was the kind of lamp which was universally used. It had been his duty to say on a previous occasion that Mr. Lane-Fox's platinum or iridium lamp was an anticipation of Edison's, but he said so unsuccessfully, Edison in the result winning both the actions. As the matter had been so fully thrashed out in those trials, he did not think anybody would care to incur the expense of trying it again. The patent, he believed, expired next year. The peculiarity of Edison's patent was a filament of carbon made artificially of some

vegetable matter usually, and carbonised after it was made into its filamental form, and then enclosed in as perfect a vacuum as could be got.

Mr. JUSTICE A. L. SMITH asked if it were conceded that the difference between Edison's and Mr. Lane-Fox's was that one was platinum and iridium and the other carbon.

Sir HORACE DAVEY said, Yes; but there was no vacuum in Mr. Lane-Fox's lamps. It was suggested that nitrogen had the same effect as a vacuum, because what was noxious in the atmosphere of the air was hydrogen and oxygen, and, nitrogen being an inert gas, if that was there alone it was the same as a vacuum. That contention, however, was not successful. His observation was that the lamp the defendants used had been determined by the Court of Appeal to be essentially different from, and not anticipated by, anything which Mr. Lane-Fox propounded. With regard to the words in the plaintiff's specification, in connection with fig. 5, "One pole of the electric lamp is connected with the earth, *e*, and this may be conveniently effected by means of gas or water pipes, where such exist," &c., he believed, looking at that diagram, his witnesses would tell his Lordship that that was the familiar way of diagrammatically drawing an earth plate at that time, that looking at that, any electrician would have understood that the patentee intended to make his return in the way that was perfectly familiar in the cases of telegraphs and some other purposes, namely, by means of one wire, the negative or positive end of which, instead of going back to the source of the electricity so as to complete the circuit, being stuck into the earth by means of an earth plate. That did not in the least exclude the fact, which his learned friend might have the benefit of, that if the actual earth was impossible, an equivalent might be found of conducting wire. The point he wished to make was, that the primary meaning of the specification and of the drawing was the soil itself.

Mr. JUSTICE A. L. SMITH: That is not a matter of expert evidence, is it?

Sir HORACE DAVEY said some of Mr. Lane-Fox's experts thought it meant every kind of return conductor; others, including Mr. Lane-Fox himself, thought it meant not every kind of return conductor but an uninsulated conductor, or, as he put it in chief to the Attorney-General, "any return conductor where insulation is not required." By that he understood Mr. Lane-Fox to mean any return conductor other than one which was specially prepared or used for the purpose, for example, a return either by the soil, or by the rails of a tramway, or by the water pipes and gas pipes, if such return were feasible. In his (Sir Horace's) opinion a great deal of this was idle controversy, because his points were two. First, he said that Mr. Lane-Fox meant what was understood by the earth in the popular proper sense, and that he expected to derive particular advantages from the use of the earth, great advantages in respect of economy, because he saved the expense (which was very great) of a return copper conductor. Secondly, he would derive advantages from the earth in respect of the loss by resistance. In every copper conductor or metallic conductor, varying, of course, according to the specific conductivity of the material, there was a certain loss in potential or pressure by reason of the resistance of the conductor itself.

Mr. JUSTICE A. L. SMITH: Do you say that there is more loss in wires than in soil?

Sir HORACE DAVEY: Yes, my lord, that was one of the advantages Mr. Lane-Fox expected to derive. His proposition was that where a patentee described a particular mode (although that mode might cover for the purpose of the patent equivalent modes) in which his invention was to be carried into effect, and expected to derive particular advantage from the use of that particular mode, then that particular mode was an essential element of his combination. Even if a benevolent construction were given to the patent, the use of the words "the earth" at any rate included the soil; and he might almost say he was entitled to say it was admitted by Mr. Lane-Fox and his witness, that for the purpose of an installation and distribution of electric light, having regard to the largeness of the current required, and the other conditions under which the current was returned, the earth (the soil) could not be practically used for the purpose. He should endeavour to establish by evidence that it had been tried, and that it had been found that the earth itself would give such a very bad return-circuit as to be practically useless for the purpose of electric lighting. There was no direction to any person taking the patent into his hands and endeavouring to carry it into effect, that he was to avoid using the earth as the return conductor, and the earth—he thought it was substantially admitted by Mr. Lane-Fox himself—would not be suitable for the purpose. What was it the patentee intended to tell them? He submitted that in the passage, "The other pole of each generator is connected with the earth so that the conductor and its branches and sub-branches will be perpetually in a state of electric tension, tending to develop currents in every direction to the earth." The word "earth" was not used in any technical sense, but that what the patentee really meant was that the other pole or electrode of each generator was to be connected with the earth by the well-known means of an earth plate. That was what his witnesses would say would be the idea conveyed to their minds from the knowledge they possessed of electricity, and the mode in which it was used in the year 1878. The only grammatical construction of the passage, "One pole of the electric lamp is connected with the earth, *e*, and this may be conveniently effected by means of gas or water pipes, where such exist," was that the gas and water pipes were to be the means of connection between the return wire and the earth. That seemed to him to be made clear by what Mr. Lane-Fox said in his very lucid lecture or address which he gave on the future of electric lighting, on May 17th, 1882, at the Royal Institution. If what Mr. Lane-Fox then said was a true exposition of his patent of 1878, he did intend to claim as part of the combination, for which he claimed the monopoly, the idea of using the earth in some form or another, and he thought he would extract some particular advantage thereby. His (Sir Horace's) reply was, the defendants did not use the earth or anything like it; they had an insulated copper conductor. Some suggestion had been made in the course of the evidence that their conductor was not as well insulated as it ought to be; but, according to his instructions, the return conductor was insulated in exactly the same way, and to the same extent, as the outgoing conductor. Therefore if a return by means of the earth were part of the plaintiff's combination, his answer was the defendants did not use that, and therefore did not infringe that particular combination, and this being a combination of several things, neither of which was claimed as a novelty or as being useful (and had, in fact, been disclaimed), the patentee was strictly confined to the combination he described.

Mr. JUSTICE A. L. SMITH: Do you say it is necessary to infringe all parts of a combination?

Sir HORACE DAVEY: You must infringe the essential parts, my Lord; and if this is part of the description from which he sought an advantage, then it is an essential part of the combination.

Mr. JUSTICE A. L. SMITH: Do you say, supposing there are two essential parts in the combination patent, A and B, and you infringe A and not B, you cannot be hit by that?

Sir HORACE DAVEY: No; not if neither A nor B is claimed separately, and if it is a mere combination patent.

Mr. JUSTICE A. L. SMITH: I am not clear about this.

Sir HORACE DAVEY: The combination is the claim—the use of A and B. If you use A and C that is not an infringement, or if you use A without B, that is not an infringement. It is the combination which is the novelty sought, and you may have a perfectly good patent for a combination where each element of the combination is old, provided that there is invention and ingenuity in the mode in which the two elements of the combination are combined together; but if the so-called invention merely consists of saying, "I use A and I use B, that is not a good combination, because there is no invention. If there is what the law calls "invention" in the mode in which you combine A and B, neither A nor B being claimed separately by itself, all the patentee has a monopoly of is the combination itself.

The ATTORNEY-GENERAL: I do not dispute that.

Mr. JUSTICE A. L. SMITH: Now give me the authorities.

Sir HORACE DAVEY gave his Lordship the references asked for, and then asked, assuming that a return insulated wire conductor would come within the term "earth" in the sense that it was an electrical equivalent, what it all came to? The plaintiff could not deny that "the earth" included the use of the earth itself (in fact, they had Prof. Perry saying so), and if it were found that an attempt to use the earth itself for the purpose of completing the circuit was practically useless, what became of the patent? There was then a deficiency of specification, because the workman or electrician who had to take this patent in his hand, and, being confined to it construct this system, was told, *primâ facie*, that he was to use the earth. But assuming that that was equivalent to a direction to him that he was to use the earth or any electrical, it was one of two alternative things that he might use—either the earth itself, or an insulated return wire conductor; and if one alternative would do, and the other alternative would not do, then the patent was hopelessly bad. That exact point had been decided in the House of Lords in the case of Simpson *v.* Halliday.

Mr. JUSTICE A. L. SMITH: Supposing it was feasible in 1878 to come back by earth and then the Board of Trade interfered afterwards, would that smash up the patent?

Sir HORACE DAVEY: No, my lord.

Mr. JUSTICE A. L. SMITH: Then you must say it was unfeasible in 1878.

Sir HORACE DAVEY: Yes, my lord; the directions of the Board of Trade cannot make any alteration in the rights of a patentee. His point on this branch of his argument depended on his proving (if it were not already proved) that the use of the earth as a conductor in the mode then known to electricians of using the earth as a return conductor, by means of an earth plate, was perfectly impracticable. He thought he should show that he had the high authority of the patentee himself for saying so. Prof. Perry said he thought an earth plate, about half the size of the wall of the court they were in, would be successful, though it might have to be covered with platinum. But Mr. Lane-Fox disagreed with that, and he thought Prof. Perry was mistaken; at a short distance the use of a soil return would be ridiculous; no one would think of using such a thing.

Mr. JUSTICE A. L. SMITH: My note is, that Mr. Lane-Fox said the size of the necessary earth plates for return currents would be unwieldy, certainly he should say impracticable, because of its largeness.

Sir HORACE DAVEY agreed that his Lordship's note summed up the discussion. But that was a thing that any electrician would have seen for himself? He supposed his learned friend would not deny that Prof. Perry was an eminent electrician, and Prof. Perry said that in reading the specification, by the term "the earth" he thought patentee meant the globe of the earth, or any return conductor. There was no doubt, therefore, that in Prof. Perry's opinion this specification did contemplate the use of the earth itself by the means of earth plates. It was impossible for his learned friend to say, after that evidence, that an electrician, taking the specification in his hands, would have known by reading it that he was not to use an earth plate; and if an earth plate would be an impracticable mode of carrying out the plaintiff's invention, then the electrician would first have to try an earth plate, and then he would discover, by his experiments, that it would not be a successful mode of effecting the completion of the circuit. If that were so, it came exactly within the authority of Simpson *v.* Halliday. Mr. Lane-Fox went on to say "the electromotive force of the electric conducting mains should be kept as nearly as possible constant at, say, 100 volts, or British Association units of electromotive force." That was a direction, and, like so many of the plaintiff's directions in his patent, a counsel of perfection; but it was nothing more; the plaintiff did not tell them

what was to be done. The batteries, the plaintiff said, were placed "between the main and the earth." His (Sir Horace's) scientific and practical witnesses would tell the Court that this was of very material importance. In Mr. Lane-Fox's system, he believed he was right in saying that the current would reach the lamps at the same potential or pressure as it would reach the batteries.

Mr. JUSTICE A. L. SMITH: He says you may hang the batteries about.

Sir HORACE DAVEY said that before the current reached the battery, there would be a loss by resistance, so that it would reach a lamp near the generating station at an actually higher pressure than it would reach the battery; but in the defendants' system they confined, manipulated, and regulated the current in such a way that the surplus over the pressure which they desired to reach the lamps was taken out and used for overcoming resistance on charging the secondary batteries. The portion, therefore, that the defendants used was very material. Then the patentee told them that the batteries would serve "as a kind of reservoir for electricity." What was a reservoir? He thought that word was as well known as any in the English language. It was for the purpose of storing the material in question, whether it were water, gas, or electricity, for use when it was wanted on a subsequent occasion. There was nothing there pointing to any use of the Planté batteries except the very use for which Planté described and introduced them, namely, storing up energy for use by the customers when required. "The cells should have a very large conducting surface, and there should be several batteries connected up at various points of the mains, so that by increasing the electromotive force when not much electricity is being used, they will become charged, and the electric force will be stored up in them, so that a sufficient supply will be available when the electromotive force falls, owing to the draft from the mains, when the force is most used and needed." "Charging," he should have thought, would not have given rise to very serious controversy. He would not go into metaphysical questions, but he submitted that charging meant that you were to fill the batteries to their capacity, having regard to the purpose for which they were to be used, which was for supplementing the load from the dynamos when a heavy load was on, or "when the force was most used and needed," which meant at night. In other words, the patentee there suggested an economical and useful way of making an installation for lighting a number of lights in a district by not having to use a plant which was up to the maximum of what was required for the whole district, and at the same time saving the expense of the wear and tear of having the engines standing idle, by having the use of them when not wanted, for the purpose of giving so much light for the purpose of storing up electricity when it was required. That that was the meaning of that passage in the specification was shown by Mr. Lane-Fox in the lecture he delivered at the Royal Institution. It had no more, in the view of this patentee, according to the description in his specification, to do with regulation, than any other specification that could be named. The other side were entitled to say that it was inherent in the system—that if it were used for this purpose it would regulate the electric current. Regulation might be an incidental advantage that flowed from it, but of course the patent could not be taken out for an inherent advantage in the system, if the system was not workable for the purpose for which it was described. In December, 1878, Mr. Lane-Fox wrote to the *Times*. So far from having supposed he had made this astounding discovery or invention which his (Sir Horace's) learned friends spoke of in such laudatory language, when he proposed to himself the question, "Why has not electric lighting been introduced?" He answered, "You cannot get a steady current." But he said this difficulty would disappear—when? When his secondary batteries were used? Not a bit of it; but when you have a number of generators on the circuit, and when you use a condenser. It was inconceivable to his mind that a person who conceived he had made a discovery which had made incandescent lighting possible and agreeable to the eye, should, when his attention was called to an objection to it, based on its supposed inconstant quality, appeal not to the discovery he had made, but to what he called condensers. The defendants said that in order to charge your batteries you must have electricity exceeding by something between 10 and 25 per cent. the pressure of the current you require to draw from your batteries, so as to obtain a current from them of the potential or pressure of 100 volts; and, secondly, that if you use in your mains, by means of your dynamo, a current of that high potential, say, anything above 10 per cent., it will be injurious to the lamps. The fact was denied by the plaintiffs, and it was alleged that you could charge your storage batteries so as to produce a current of 100 volts, with a difference of voltage of 1 per cent. only. By cross-examination of the plaintiff's witnesses, it was elicited that that statement was only a relative statement, applicable to conditions to which this patent did not apply; and then it was admitted that in order to charge with such a current as Mr. Lane-Fox contemplated it would require from 110 volts upwards, and that 110 volts would smash the lamps. Then the case took this turn: It was said that Mr. Lane-Fox contemplated batteries with a very large conducting surface, the rise and fall in which would not be so much as with smaller batteries, and that his directions were not to charge fully, but only incompletely. That was the connection in which the famous "plateau" theory was put forward. Every one of the plaintiff's witnesses was asked to give data for saying what the size of the battery should be, but they could only make a rough guess. That was not the way to deal with the patent; and therefore he said that it was not true that if the size of the batteries were increased, the rise in the potential or pressure, which was injurious to the lamps, would be got rid of. Of course, if the conducting surface were increased to infinity, the resistance would be infinitesimal; but if this were done in any practical way this rise and fall in potential would not be got rid of, and Mr. Lane-Fox's suggestion was incapable of being worked in a satisfactory manner. He took it to be admitted on the evidence that if this rise and fall did exist, it could only be counteracted by some such means as the defendants had suggested, and he submitted that the patentee did not give any sufficient directions for getting rid of it. The expression was relied on that the cells should have a very large conducting surface. He (Sir Horace) said there was nothing there to indicate to the electrician taking this specification in his hand, that there was to be any larger conducting surface than would be necessary for the purpose of storing up the electricity which was afterwards to be used as a supplemental current to the current from the dynamos. The nearest approach to a construction given was that of Prof. Barrett—the cells should be relatively large, compared with the installation, as well as of very large conducting surface.

Mr. JUSTICE A. L. SMITH: Relatively large to what?

Sir HORACE DAVEY said: "A very large conducting surface, sufficiently large to give the right surface with a small difference of pressure." If that were in the patentee's mind, it was incumbent on him to tell the world so. How was the electrician who took this into his hand to guess that that was the meaning of the word "large," that being a relative term? If so many ampère-hours to the square foot had been given, there would have been an indication and a direction to the electrician taking the patent in his hand which would enable him to understand, to appreciate, and to follow what the patentee meant; but he affirmed that if (as his learned friend now said) size or dimensions were material for the purpose of this patent, the patent failed for want of sufficient directions—that "a very large conducting surface" was insufficient. Dimensions made all the difference, according to Prof. Barrett, between the system working or not working. If dimensions were material, then he said there was no sufficient guide or indication or direction given in the plaintiff's patent to enable the electrician to carry out the invention without the application of thought, attention, and invention. He therefore submitted, on these two points, that directions ought to have been inserted in the patent, and none the less so because of the novel suggestions which were made by Mr. Lane-Fox. He admitted that very little was known about incandescent lighting, for the simple reason that there was no incandescent lamp which would burn at that time. But that was an additional reason why a sufficient explanation should be given to the persons who were to put this patent in force. He had the highest authority for that, because Mr. Lane-Fox said the whole question was very badly understood at that time, and that the workmen were so stupid. This was practically a new industry, and men had to be educated to understand the work. That being so, it was all the more incumbent on the patentee to give such directions as would be an adequate guide to the electrician who had to take the patent in his hand, and work out the process from it. In point of fact, Mr. Lane-Fox having made some suggestions, now came forward, in the fourteenth year of his patent, to ask that these suggestions should be read by the light of accumulated experience, which had been gained since the incandescent light had been introduced, and put into force by law. It was possible that at the present day a skilled person like Prof. Perry, or Prof. Silvanus Thompson, might achieve success by their experience and knowledge which they had gained in working this process; but he absolutely denied that anybody in 1878 could have done so. The learned counsel then cited authorities to show that a specification which cast on the public the expense of labour and experiment was bad.

Mr. JUSTICE A. L. SMITH: It is the law that a skilled workman must be able to carry out the invention, but he is not to invent.

Sir HORACE DAVEY: The patent ought to be understood by the public.

Mr. JUSTICE A. L. SMITH: Not by a baker.

Sir HORACE DAVEY: No. What I mean is that it is not enough to produce it to Sir Frederick Bramwell, Dr. Hopkinson, or Prof. Silvanus Thompson, and say, "Can you carry this out."

Mr. JUSTICE A. L. SMITH: No. The process must be capable of being worked out by an intelligent electrical workman.

Sir HORACE DAVEY agreed. How was the workman, from a vague general direction that the cells were to have a very large conducting surface, to know what was meant? How was the workman, from a direction that he was to use the batteries as reservoirs, and that he was to charge them during the hours when there was not much light burning, to know that he was only to charge them up to a certain undefined limit? It was ridiculous to say that an electrical workman taking the plaintiff's specification into his hand would know this.

Mr. JUSTICE A. L. SMITH: They say on the other side that the engine driver must knock off when he gets his light too bright.

Sir HORACE DAVEY: Then the batteries will not be stored.

Mr. JUSTICE A. L. SMITH: They say you have got it up to the plateau.

Sir HORACE DAVEY: Yes. My answer to that is two-fold. In the first place you won't store your batteries; and, secondly, that the engine driver is expressly told to increase his electromotive force during those hours. The plaintiff contemplated having enough cells to store the electricity required and letting it go on as it liked. Ours is quite different. We have a larger number of cells.

Mr. JUSTICE A. L. SMITH: Do you drive at 100 volts?

Sir HORACE DAVEY: We drive at 140. With regard to "regulation," he ventured to assert that to call this patent a patent for regulating the electric current was altogether a misnomer—that it was merely a combination of the use of secondary batteries as reservoirs with an arrangement of incandescent lights in parallel. He ought to allude to one point which his learned friends made as to the Queen's Gate station. They said, "Oh yes, you have exactly what the plaintiff describes; you have a secondary battery placed on your mains away from your generating station." That was true and it was untrue. The defendants had a battery connected with wires at Queen's Gate, there were no lamps on it. The battery at Queen's Gate was actuated by a dynamo at Kensington, and the wires which

connected the battery at Queen's Gate with the dynamo which actuated it at Kensington contained no lamps; so that for any electrical purpose it was not placed on another part of their system, but was in exactly the same position as if it were at their system. There was only one other point with regard to this regulation. It was said by the witnesses (particularly by Prof. Barrett) that you could not help regulating, that it was inherent in the system, that it was one of the properties of storage batteries that they would regulate whether you liked it or not. If so, it was not invented by Mr. Lane-Fox. Mr. Lane-Fox did not invent something which was inherent in the use of storage batteries, assuming that he pointed out their regulating action. Mr. Lane-Fox only pointed out what was a property common to them, or, in other words, all he pointed out was a better or more profitable use which might be made of a well-known machine. That was not proper subject matter of a patent. This was decided in the case of Ralston *v.* Smith, in the House of Lords.

Mr. Justice A. L. Smith: Supposing he found out that it was inherent.

Sir Horace Davey said that would not do. Illustrations had been given of that. Suppose a man had been accustomed to eat his soup with a spoon, and somebody suggested that a spoon would be a good thing for eating peas, you could not have a patent for that; it was an inherent part of the advantages of a spoon. A man could not be prevented from using his machine in the most profitable way.

Mr. Justice A. L. Smith: You can get a patent by putting two things together, if there is inventive genius between?

Sir Horace Davey: If there is invention.

Mr. Justice A. L. Smith: Nobody knew that Planté's cells would work as they are supposed to work. I am assuming, for the sake of argument, that by inventive genius Mr. Lane-Fox has devised the method of putting the batteries on the mains.

Sir Horace Davey: Your Lordship puts in the inventive genius. He may have made a discovery, but it is not a discovery that is an invention. He must discover and describe some new use. He must discover and describe not only some new use to which I can put the machine I already possess, but he must discover some amendment or improvement in that machine. What the plaintiff has done is merely telling me of a useful application I can make of my own machines.

Mr. Justice A. L. Smith: Do you say that you cannot get a combination patent by bringing two known things together by inventive genius?

Sir Horace Davey: Certainly. The House of Lords have held that you cannot have a patent for combining several things in one machine, unless you can show that there is thought, ingenuity and invention in the mode of combination.

Mr. Justice A. L. Smith: That last proposition of yours I agree to.

Sir Horace Davey said his other proposition was that one man could not get a patent so as to prevent another from using his machine in the most beneficial and profitable way. The learned counsel was citing authorities on that point, when

The Court rose for the day.

Friday, March 4th.

Sir Horace Davey, Q.C., continuing his speech, said it would be for his Lordship to say what details were necessary for carrying out the idea the patentee had in his mind, and whether the details given were such as would enable a competent electrician to take this specification in his hand, and find within the four corners of that document directions for making a workable system His proposition might be summed up in a single sentence: Some details were necessary for carrying it out, and those details were not given in the specification. He submitted that there were defects in the description in the specification which made it not a useful workable invention for the purpose of storing the electricity with a view to supplementing the current from the dynamo when the load was heavy, and thereby saving the cost of plant. If his Lordship came to the conclusion that in order to make the patentee's description a workable thing, details and further provisions were necessary, and that the defendants had supplied those details and those deficiencies so as to make what was a mere general idea in the plaintiff's patent into a workable process, then he ventured to say there was no infringement. He asked his Lordship to consider whether, taken at its best, the patentee had disclosed any invention which was the proper subject-matter of a patent; whether his invention was anything more than placing side by side two known processes, and using them together. He ventured to submit that that was not proper subject matter of a patent. If indeed there was an invention, an adaptation in the combination of the two things, that might be proper subject matter of a patent; but if the patent merely consisted in saying "I use at the same time a well-known process or machine A, working for exactly the same purpose and in the same way in which it has always been used, and at the same time I use another process or machine B, and I use those side-by-side simultaneously," then, he submitted, that was not proper subject matter of a patent. Evidence would be given on that point, and he would cite authorities upon it. Adverting to the strange way in which this case had been brought before the Court, he asked what was the evidence as to the actual uses of this so-called invention, and what was the evidence as to the mind of the patentee on the subject? Evidence would be called before the Court as to the installation of the electric light in the Law Courts. That installation was put up in 1882 by the well-known firm of manufacturers of electrical apparatus, Messrs. Crompton and Co. The substance of the evidence would be that an attempt was made to use accumulators without any mechanical apparatus or means of controlling the current, and that the result was a failure, and that the consequence was that the accumulators had to be removed, very much to the loss of the contractor, and that from that time forward the light in these courts had been provided without any accumulators at all. No doubt Mr. Lane-Fox would say that the accumulators were Sellon & Volckmar's, which were not so good as other secondary batteries. The conclusive answer to that would be that the general public could not be expected to be wiser than the patentee himself, and that when the patentee desired to put his system in work, he used those very batteries. According to Mr. Lane-Fox, the failures were never on account of an imperfection in the system. But it was found that these very batteries of Sellon and Volckmar's worked perfectly successfully when you supplied the defects (as he called them) in the description of the specification with the necessary mechanical contrivances for manipulation of the current. Evidence would be given that it could not be pretended that Mr. Lane-Fox's installation at Lady Conyers's (even if it had been successful) could be regarded as a fair trial of his system. As Prof. Barrett ran with a current in excess of what the lamps required, the storage batteries were not used for the purpose of storing the electricity and supplementing the current from the dynamos, because that was not necessary, but were used only for the purpose of getting rid of the disagreeable pulsations of the gas engines, which at every second or third beat made a very visible and appreciable pulsation. If that were so, this miniature installation of Prof. Barrett for the purpose of lighting his laboratory (which worked with perfect success) was directed clearly to a different matter from that which formed the subject matter of this patent, and was no evidence whatever of the successful use of the plaintiff's invention for the purposes for which, according to the defendants' submission, the patentee had described its use. He had placed before the Court a model which would be proved to correctly represent the mode in which the electric current was treated at the defendants' works. He ventured to submit that there was no element of similarity in the combination employed by the defendants and that described by the plaintiff, except that the defendants used secondary batteries, and that they also used the multiple arc or parallel system of distribution. But the user was in a totally different way. The defendants' batteries were not placed in the same position, and they did not desire to have a number of batteries dotted about the place. The plaintiff proposed to let his batteries store themselves and discharge themselves at their own sweet will, while the defendants, on the contrary, confined and controlled the current by means of mechanical devices in such a manner as to achieve the object they wanted. He should submit that those details, and that system of mechanical apparatus was the result of thought, ingenuity, and experiment; in fact, it would be proved that it was the outcome of a great deal of expense, experiment, and ingenuity extending over several years. Another feature in the defendants system (which would be explained by the witnesses) was the feeders, the use of which was to correct the loss from the mains. On the whole, he submitted that this patent, whatever the merit of the general principles announced in it, was a bad one, and one that did not entitle the patentee to the protection of the patent law. In fact, the patent itself, he took the liberty to say, was a mere statement of crude and undeveloped principles and of vague generalities which required detail, thought, and ingenuity to supply the details which would carry them into effect; and he submitted to his Lordship, on the evidence which would be produced, that the Court ought to come to the conclusion that there had been no infringement by the defendants of the plaintiff's so-called invention.

Sir Frederick Joseph Bramwell, examined by Mr. Finlay, said he was one of the directors of the defendant company, and was familiar with the process carried on at the works. He had examined the plaintiff's original and amended specifications.

It has been stated that "the earth" had a technical meaning which in 1878 would have conveyed to any electrician that any return conductor was meant?—I should not have thought so. "Earth" without the "the," I should say, might have meant any kind of return conductor.

If it were practicable, would there have been any advantages in returning by earth?—Yes, economy in the material of the conductors; about half of the total expense of the wiring of system where there are two metallic conductors.

Would fig. 5 have been differently delineated if anything but the earth had been intended?—Yes, I should have expected return conductors would have been indicated.

What does the letter *e* to a draughtsman denote?—Earth plates, by which connection with the earth is effected for the return circuit.

Does that figure convey to your mind the idea of the soil as the vehicle for the return circuit?—It does, and that is corroborated by the letter-press.

In your judgment, is the return by the soil practicable for a system of electric lighting?—I do not believe it to be so, having regard to the large number of ampères we have to deal with.

What is the difference between the current used in telegraphy and the current for electric lighting?—In telegraphy the current may be measured by a very small fraction of an ampère; in electric lighting by a great number of ampères.

Have you ever known a return by the earth successfully employed in the case of an electric lighting installation?—No. I mean I take water as being soil. I should take the river as being soil, though a very good one as compared with the ordinary soil. I exclude from my answer return by the skinning of an iron ship in the water.

Why is return by earth impracticable?—Because of the large number of ampères involved. I think that difficulty could not be overcome.

In your opinion, is what the plaintiff says with regard to making use of the gas and water pipes practicable?—No, I think it would corrode the pipes.

In 1878, was there novelty or invention in the plaintiff's combination?—To my mind it was an obvious use of a then existing implement, namely, a storage battery. Planté's battery was essentially a battery which was a kind of reservoir for electricity.

Was there novelty in the plaintiff's application of the Planté battery?—No. I think the second part of Clarke's specification points to a similar condition of things.

Does the specification of Mr. Lane-Fox, if given to a workman of intelligence and acquainted with the subject, contain sufficient directions for carrying out his system successfully?—I think not.

Could it be worked for practical purposes successfully?—I do not believe it could. In my mind the vice of the plaintiff's arrangement is the continuous connection of the batteries with the lamp circuit and the automatic action of the system.

What do you say with regard to Prof. Perry's suggestion of increasing the area of the plates?—It is commercially impossible because of the excessive cost, if for no other reason.

WITNESS then said that the defendants did not use the soil at all as a return conductor, but that they used conductors for return insulated in precisely the same manner as the conductors used for the flow. Whenever they could find room between the flags of the pavement and the flags of the cellars to build a rectilinear conduit they did so, and in that conduit they had bare copper conductors, the air being the insulator and the conductors being supported on insulated supports. The object of the feeders used by the defendants was to get rid of the fall of pressure that would occur if the lamp circuit were connected to the generating station. That loss was occasioned by the resistance in the main through which the current was travelling for the purpose of supplying the houses on the line of the main. The feeding mains had no lamps on them at all, and the current reached the point of delivery at the requisite voltage. At the point where the feeding main joins the lamp main, the defendants preserved the voltage they required in the lamp main, and then they had a return wire which indicated at the generating station that at that point they had the needed voltage. Having regard to the quantity of current being taken, it was the duty of the person in charge to see that the voltage between the feeding main and the lamp main was kept constant. At Kensington the defendants had generators and secondary batteries, and at Queen's Gate they had secondary batteries. They had between the Kensington station and the Queen's Gate battery station a pair of charging mains. There were no lamps on this at all. In neither case were the batteries charged from the lamp circuit, nor was the arrangement automatic. The witness here explained on the model the mode of sending the electric force from the dynamo to the secondary battery, and from that to the feeders.

Mr. JUSTICE SMITH: How do you get the current into your secondary battery?—From the charging mains.

Mr. FINLAY said his point was that their secondary batteries were between the generators and the lamps; sometimes the current might go into the lamp circuit without going into the secondary battery at all.

In the defendants' system there are no lamps supplied from mains between the generator and the secondary batteries?—None.

In Lane-Fox's system there, on the contrary, there are?—Yes.

Is that an important point of difference?—I think so, in the respect that you can have the necessary variations of voltage that occur between the charging and the discharging of the battery. I believe that in ordinary working 125 volts is the normal energy required to charge the batteries.

When the secondary battery is discharging, is the switch used for the purpose of keeping up the requisite force as the charge goes on?—Yes; we have more cells.

Is that arrangement necessary for the working of the system?—I believe so. I believe continuous action and automatic working, so that there is no hand regulation, is incompatible with successful working.

For what purposes are secondary batteries employed by the defendants?—For the purpose of economising the labour, and for the purpose of working our steam engines more efficiently. Our engines are non-condensing, and a non-condensing engine falls off in efficiency if it works with a light load. We economise by being able to stop our engines for many hours so that we do not need a double shift of men, which we should otherwise need. A further use is that if (in the extremely improbable circumstance) all our machines broke down, we should still be able to supply the whole district for several hours from the batteries alone.

Are installations of lighting without the use of secondary batteries common?—High tension, certainly; low tension, I have no doubt there are installations without a secondary battery.

Have you examined the installation in these Law Courts?—Yes.

What is the tension here?—95 volts at the poles of the machines, and 90 at the switch board, I believe.

Is there any difference between the working of dynamos with steam and with gas engines?—Very considerable. The gas engine is a very irregular motor, and apt to produce flickering, but that can be considerably mitigated by a fly-wheel on the dynamo itself, and a slack-belt between the dynamo and the engine.

Cross-examined by the ATTORNEY-GENERAL: Had you made electric light a special study in 1878?—I should say not.

The opinions you have given us are the results of your last six or eight years' experience in this system?—Yes.

Will you tell me any text-book or other publication in which such a use of secondary batteries as they are put to according to Mr. Lane-Fox's specification is referred to?—I think Clarke's patent contains it; Clarke's is as good as any.

Can you show me any publication prior to the plaintiff's as to the importance of keeping the pressure constant in the mains for incandescent lighting?—I do not think I can.

What batteries do you use at Kensington?—The Crompton-Howell battery.

Are they lead plate and sulphuric acid batteries?—Yes; they are not pasted batteries.

WITNESS said, in further cross-examination, that anybody between 1881 and 1885 wishing to use secondary batteries, would have used pasted plates, thinking he had a better thing than the old Planté. The Kensington batteries were more like plaintiff's than Faure's, because they were not pasted batteries. The defendants' district was broken up into a collected area of lamps; it was fed at several points. It was the fact that in each of the circuits the second battery connected with the return feeder. Taking the return main alone as being earth, the secondary battery was in the same position as Mr. Lane-Fox's; but this was not the case as regarded the lamps.

Is not the sole distinction between the position of the secondary battery in Lane-Fox's patent and in your Kensington system, that in your patent it is between the generator and the lamps?—My distinction is that in the Lane-Fox patent it is continuously connected with the lamp circuit, and in ours it is not.

Eliminating connections for the moment, from your point of view of position, does it make the slightest difference to the constancy of pressure at the lamps, while a given number of cells is coupled up, whether the battery is between the generator and the lamps or the lamps are between the generator and it?—For short intervals of time, no; for continued working, yes.

Is not the object of putting the battery between the generator and the lamps by the defendants in order that you may get the opportunity of cutting in and out cells for charging and discharging?—Yes.

Pressed as to whether the model as placed by the Attorney-General did not represent Lane-Fox's system pure and simple, WITNESS, somewhat reluctantly, answered that it did. He then went on to say that the generators running and the batteries coupled up, a circuit would remain from three-quarters of an hour or longer without any alteration of the tension. He did not know that the secondary batteries there were acting as regulators any more than the engine was; they might be acting conjointly with the engine as regulators, but there would be the same regulation without them. The switches did not fulfil exactly the function explained in Lane-Fox's specification, because he did not see that they were taking the charges when the pressure was high and giving it out when it was low. The secondary batteries were helping to maintain a constant pressure at the lamps while they remained in that position. He agreed that Mr. Lane-Fox contemplated the generator running while the lamps were alight. It was known that the sudden putting on of more lamps either raised or lowered the voltage of the generators unless it were corrected. The secondary batteries would tend largely to correct that. To that extent the secondary batteries would act as tending to maintain a constant electromotive force at the lamps. Switches were perfectly well known in 1878, as was the normal or standard voltage of a Planté cell. The increase of area of the plates in every cell did not alter the voltage one fraction; it only altered the number of hours at which a given voltage would be maintained with an equal discharge.

Adjourned for the day.

F. W. Mason.—This case came before Sir P. H. Edlin, Q.C., Chairman, sitting at Clerkenwell. Frederick William Mason, 22, described as an electrician, was indicted on many charges of obtaining goods by false pretences. Mr. Bodkin and Mr. Travers Humphreys prosecuted on behalf of the Treasury. The prisoner was charged with having obtained a number of electrical instruments from different manufacturers by falsely pretending that he was carrying on a genuine business for the sale of such articles, and by other false pretences of the same nature. He had represented himself as trading under various names at various places—as F. W. Mason & Co., electrical engineers, at 11, Great Sutton Street, and afterwards as the Aluminium Electric Company at the same address, as Clarke and Montague at Cloudesley Place, as the Clinton Electric Company at Dulwich, the Springdale Electric Company in High Holborn, the Financial Inventions Company at 4, Featherstone Buildings, and in other names at other places. From the evidence of witnesses whom the defendant called, it appeared that he did do a certain amount of business in a small way as an electrician, but it was alleged that in several cases he had ordered instruments from manufacturing firms saying that they had been ordered by customers, while, as a matter of fact, he had no customers for them, and that he failed to pay for them, and in some cases it was shown that he had sold the instruments, as soon as he got them, to a shopkeeper named Rarp, in Clerkenwell, for less than he owed for them. He had also defrauded a certain Lieutenant Dennis, who had engaged him to fit up a canoe for him with an electric motor, of a cheque for £12. The jury found him guilty. A detective stated that the prisoner was formerly in the service of a firm of electricians, and, being put at the head of one of their establishments, he stole from them instruments of the value of £200 or £300. When discovered he offered to repay them, and they did not take proceedings against him. Afterwards, when they asked for the money, he told them they had compounded a felony, and dared them to prosecute him. In 1890 he became acquainted with a Major Moore, for whom he did some work in connection with a flying machine, and he robbed him also. Many complaints against him for offences similar to those with which he was now charged had been received by the police during the last nine months. He was sentenced to 18 months' imprisonment with hard labour.

Woodhouse and Rawson Limited v. Shanks.—In the Queen's Bench Division, on Thursday, this case came on for hearing before Mr. Justice Charles.

Mr. MONTAGUE LUSH, for the plaintiffs, said it was an action to recover the amount due for lighting the defendant's chambers at Savoy Mansions with the electric light. Mr. Shanks had pleaded that the prices were not fair and reasonable, but his solicitor had written that he would not be represented at the trial, and judgment must be allowed to go by default.

Mr. JUSTICE CHARLES accordingly gave judgment for the plaintiffs for £53 and costs.

NEW PATENTS—1892.

3,423. "Improvements in telephones." Sir C. S. Forbes. Dated February 22nd.

3,427. "A new carbon electrode for electric arc lighting, to be called the 'electric torch.'" C. A. J. H. Schroeder and H. E. R. Schroeder. Dated February 22nd.

3,443. "Improvements in electric arc lamps." G. Hughes. (Communicated by C. H. O. Japy and O. Helmer, France.) Dated February 22nd. (*Complete.*)

3,488. "An improved method of coiling up conductors of portable electric lamps." A. C. Hamilton. Dated February 23rd.

3,496. "Electrically-heated smoothing iron." W. Mitchell. Dated February 23rd. (*Complete.*)

3,512. "Improvements in the process of electrolysing alkaline salts." G. D. Davis. Dated February 23rd.

3,513. "Improvements in diaphragms for electrical cells." G. D. Davis. Dated February 23rd.

3,514. "Improvements in the process of electrolysing alkaline salts." G. D. Davis. Dated February 23rd.

3,521. "Petroleum lamp with electrical igniting device." O Imray. (Communicated by C. Wasmuth, Germany.) Dated February 23rd

3,522. "Improvements in electrical igniting devices for gas lamps." O. Imray. (Communicated by C. Wasmuth, Germany.) Dated February 23rd.

3,523. "Improved galvanic element." O. Imray. (Communicated by C. Wasmuth, Germany.) Dated February 23rd.

3,538. "Improvements in distributing and controlling electric currents in mines or other dangerous places." R. J. Charleton and H. Walker. Dated February 23rd.

3,542. "Improvements in telephone apparatus." H. H. Lake. (Communicated by W. Gray, United States.) Dated February 23rd. (*Complete.*)

CORRESPONDENCE.

Thefts at the Crystal Palace.

Since we wrote you last concerning the above, we have had stolen from our exhibit four watch receivers, which were securely stapled near the top of our show board.

With further reference to our former losses, we may state that the way in which the instruments were appropriated, points to two things :—

1. That the thief or thieves are not of the common kind, but are experts ;

2. That they have ample time to carry on their nefarious operations.

By way of supporting these statements, we may mention that upon examining the place from which the microtelephone was taken, we found that the cord was not rudely pulled from the rosette, but the latter was neatly unscrewed and the cord released from the inside screws which secured it to the back of the rosette, and then the top was screwed on again.

The same remarks apply to the model microphones and watch receivers.

Is it not possible to put a stop to this wholesale system of robbery, which, we understand, has been practised on other firms as well as ourselves ?

The International Electric Co.,
H. Oppenheimer, *Manager.*

March 9th, 1892.

Electrical Organ Control.

I have read Mr. Conti's courteous letter in this week's issue, and while apologising for the unintentional slip regarding the weight of his armature must beg him to allow me to remove the impression that my electrical appliances are expensive. It is true that in designing them I strove towards perfection and not towards economy, yet, at the same time, it is true that the action is exceedingly inexpensive being so deemed by the 24 London and Provincial builders who have already adopted the system.

Robt. Hope-Jones.

March 4th, 1892.

Economic Aspect of Sewage Purification by Electricity.

The article in your issue of 26th February, 1892, on "The Economic Aspect of Sewage Purification by Electricity," contains grave errors about the cost of the International Company's process of purification, which you will, no doubt, point out to your readers by inserting this contradiction in your next issue. The erroneous article professes to quote from "Newton's report, &c.," published by the Salford Corporation in January, 1891. On page 56 of that report it is stated that the cost of daily purifying 1,000,000 gallons of Salford sewage by the International process would be £862 per annum, *i.e.*, 47s. 2d. per day. That estimate is excessive, though much less than 54s. 1d., named by your correspondent. It is calculated on the erroneous assumption that 6 acres of polarite filter beds would be necessary, whereas 3 acres would be ample, as estimated on page 19 of the same report by the borough engineer of Salford, who knows his business, and as proved by the experience of sanitary authorities who use the International system. Newton's estimate, subject to this correction, would read as £732 per annum, or, £2 per day for treatment of 1,000,000 gallons of Salford sewage by the International system. This is more than the cost would really be in ordinary use. The cost of treating the sludge is about the same in all systems of purification except when lime is used, which increases the bulk of the sludge and, at the same time, diminishes its manurial value.

The further statement that the International Company's process (with added ferozone) costs 90s. per million gallons of sewage treated, is a reckless assertion for which there is no foundation whatever. Ferozone is always added in the preliminary stage of the purifying process. The cost of carrying out our entire system is under, rather than over 40s. per million gallons, and the results produced are better than can be got from any other system of purification. This may be seen in Table E. on page 80 of the same report, which shows the international system of purification reduced the albuminoid ammonia in Salford sewage by an average of 79·51 per cent., whereas the other competing systems only produced an average reduction ranging from 60 per cent. to as low as 33·75 per cent.

Frank Candy, *Managing Director.*

March 7th, 1892.

P.S.—You will see by the enclosures that the "International" system is now being generally adopted. F. C.

Gas Engine Performances.

We thank you for the article in the Review upon the "Stockport" gas engine last week, but we desire to draw your attention to a portion of the matter which does not advertise with any advantage the "Stockport" gas engine. You state that "it is questionable whether the actual brake horse-power of any gas engine in continuous work is much, if any, above the nominal rating of that engine." We may state that it is absolutely beyond question that our "Stockport" gas engine will work continuously under a heavy load, and can refer you to Mr. Slingo, of Messrs. Slingo & Brooker, of 46, Solon New Road, Clapham, who are the consulting engineers to the Drapers' Company.

We have a 16-H.P. Nom., of similar size and design to that exhibited at the Crystal Palace, driving the dynamo at the Drapers' Hall ; and this engine has given an electrical output of 120 amps. at 130 volts for a continuous run of 13 hours, and it will be required to give 155 amps. at 130 volts before it will be finally accepted, a result which we have not the slightest doubt about obtaining.

You will therefore see that from the figures given the engine will be developing about 30 H.P. actual. This is not the only example that we could give you where our "Stockport" gas engines are working for long periods under continuous full load and where the brake H.P. developed is nearly equal to double the nominal.

We leave the matter in your hands, to be dealt with as you desire, but we think it is wise that you should be set right upon this point.

J. E. H. Andrew & Co., Ltd.,
Alf. R. Bellamy, *General Manager.*

March 8th, 1892.

[We fail to see that our contention has been upset. The available work at present obtained from the engine quoted is only 20 H.P. during a 13 hours' run, and we have yet to see whether the requirements of Messrs. Slingo and Brooker will be met. Perhaps they, or other engineers conversant with gas engine efficiencies, will state their experiences.—Eds. Elec. Rev.]

CRYSTAL PALACE ELECTRICAL EXHIBITION, 1892.

To form a right estimate of the exhibits at the Crystal Palace, several inspections are necessary. A chance stroll through the building will fail to give an adequate notion of the machinery and fittings. At this period one begins to appreciate the care which many of the firms have taken to make exhibits as presentable as possible. While there can be no denial of the success of the exhibition from an electrical point of view, we fear the public do not attend in such numbers as might have been expected. There are days, of course, when the Palace is inconveniently crowded, but on these days there are more attractions at the Crystal Palace than the exhibition. Still, if the public do get there, they are bound to become interested in the applications of electricity, and although the presence of the public may not directly result in business, it must be of importance that they have seen the adaptability of the electric light. We do not know of any official announcement as to the date of closing, but it seems that there is a strong desire to keep the exhibition open until June. There is much to be said in favour of such a course, although when April comes the days lengthen considerably, and there is consequently less lighting.

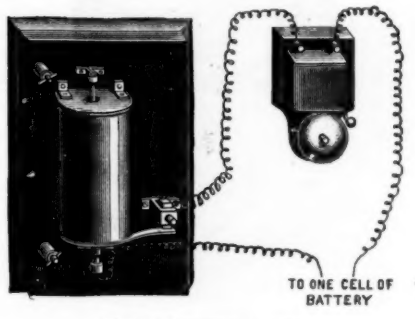
What may be termed the "side shows" attract a good deal of attention, the high voltage experiments of Messrs. Siemens invariably collecting a large audience. None the less popular is the lighting of a model theatre. In a draughty corridor, called by courtesy the Pompeian Court, a short discourse is delivered nightly on the lighting of a theatre stage by electricity. Various kinds of weather are turned on to a scene of a few feet square, representing an Alpine village. A mid-day sun is let down the back of the Alps, and succeeded by a storm, vivid flashes of lightning playing over the mimic stage. It was realistic, save for the absence of the thunder. This absence was perhaps to be regretted, and there was little excuse seeing that a good cheap thunder may be made out of tea trays.

Another feature which appeals to the British public, and which is discernible all over the Palace, is the cooking operations carried out with the aid of electricity. It was an unfortunate pancake which was suffering on one occasion. Whether it was a disproportionate mixture or not, we cannot say, but we should think a pancake, after being struck by lightning, and left in the wet all night, might present a similar appearance.

E.P.S. Exhibits.

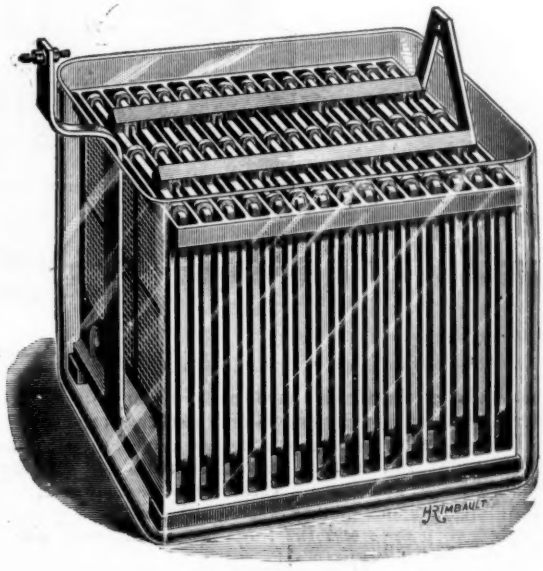
WE have not previously drawn attention to the exhibit of the Electrical Power Storage Company. At the stand in the south nave is shown King's potential regulator for automatically maintaining a normal electric pressure in a network of mains. It is applicable to all stations where the continuous current system is employed. It consists of a number of apparatus somewhat as follows:—The E.M.F. governor is a fine wire coil or solenoid in parallel with the feeders, whose function is, when the pressure rises above or falls below the permissible variations from the normal limit, to move an iron core up and down. A lever bar attached to this core carries contacts which complete a local circuit through a relay, which in its turn actuates the core of a double-acting solenoid, which operates simultaneously on sliding contacts in connection with switches for the introduction of a resistance or a counter E.M.F. The double-acting solenoid consists of a coil and movable core, which controls a number of switches attached to the counter E.M.F. cells one at a time, and even two at a time, and by introducing the latter into, or removing them from, the supply circuit, regulates, in steps of two volts, the E.M.F. on the supply mains.

The coil of the E.M.F. governor is connected in series with a "temperature compensator." This little apparatus keeps constant the total resistance of the circuit of the fine copper wire of the coil, whatever the variation in temperature of the air, by altering the length of a carbon filament which is in circuit with the coil. This alteration of length, which minutely varies the resistance, is caused by the expansion and contraction of alcohol in a bent glass tube, which presses on a column of mercury, into which one end of the filament is inserted.



E.P.S. CURRENT ALARM.

E.P.S. CELL TESTER.



E.P.S. "K." CELL.

A cell-testing voltmeter, with contact rod, is shown, for testing the electromotive force of individual cells in a battery. This is claimed to be the only instrument which enables a rapid and certain test of a battery of cells to be made.

When used during maximum discharge, the exact condition of each cell is indicated.

We illustrate the excess current alarm, which is arranged to ring a bell, and thus give warning when the battery is being charged or discharged at too high a rate.

The various kinds of cells are shown—"K," or high discharge type, central station cell, containing 132 "K" type plates, in lead-lined wood box, the whole weighing 900 lbs., and which is capable of giving 500 ampères for about 3½ hours in ordinary work, or 1,000 ampères for one hour on emergency. "K" type, 17 plates in lead-lined wood box, giving 67 ampères for 3½ hours, made for ship lighting and other exposed work.

"C" type, 7 plates, for train lighting, similar to those used on the Midland and the London Brighton & South Coast, and other railways.

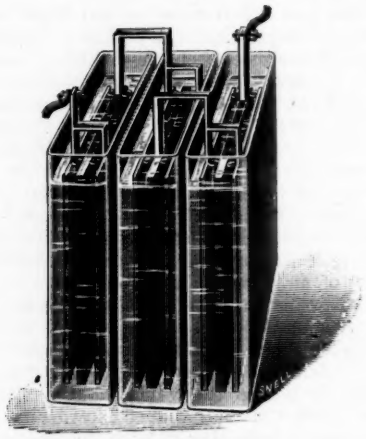
Portable E.P.S. Cell.

"E" type, 15 plates, in ebonite box, made for launch work, shaped to take advantage of the slope of the boat, and which is capable of discharging at 35 to 40 ampères. Some thousands of these cells have been working in launches during the past 4 or 5 years without needing repair.

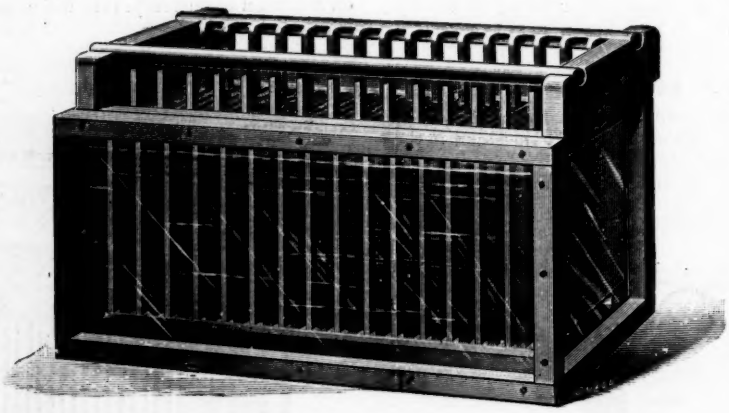
Three types of portable batteries are also exhibited, which are intended for lighting individual lamps for carriages, reading lamps, and medical work. One has four cells, each of 3-T plates; and another 8 cells, with the same type and number of plates; and the third has 4 cells, each with 3 plates of the "C" type.

"Epstein" Accumulator.

A little further down the nave is shown the Epstein accumulator. It is claimed that these batteries, formed by direct oxidation without the use of paste, are entirely free from buckling or short-circuiting, very rapid discharges can be taken without any deterioration, and their management seems to require no special attention. The rate of discharge may be fixed according to requirements up to 50 ampères per positive plate, the capacity varying according to the discharge rate between 90 and 130 ampères per positive plate. In case of emergency, these cells have for a short period been discharged at a rate equal to 70 ampères per positive plate. The number of plates is small as compared with types for the same output by other makers. We illustrate two of the principal types of this battery.



The "Epstein" Accumulator.



The "Epstein" Accumulator.

Hand Lamps.

There is an abundance of miners' and other lamps shown, which we shall describe in detail in a future issue. One of the most noticeable exhibits in this class of lamps are those made by the Bristol Safety Lamp Company. Among their many types are those made for the British Museum. These contain twice the number of cells as the ordinary lamps of this class. The special miners' type is enclosed in a solid brass case, B.W.G., No. 18; the weight is 2 lbs., but it is very strong, and a perfectly safe protection for the battery.

Besides special house lamps a travelling lamp intended primarily for surveyors and inspectors is shown. The battery fits well in an ordinary pocket, and the lamp is provided with a suitable hook for fixing it to a button hole. The company are supplying the London General Omnibus Company with these for their ticket inspectors, for which order a general competition took place some time ago. Besides these types, other lamps are exhibited, which give six candles for ten hours. Lamps similar to these are supplied to the Danish fortresse round Copenhagen.